THE

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THE

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ANALOGIES TO THE WRIGHT DEMAND SYSTEM.

THE arguments in Mr. Arthur Wright's papers, particularly his last Institution contribution on the subject, are very generally accepted by engineers as being correct. True, one or two dissentient voices are raised in protest, but it is not going further than the truth to say, that seldom do we hear an engineer actually in command of a supply system using the demand principle, say anything but what is good regarding it. The difficulty is to explain the principle to those who are not sufficiently versed in supply matters to grasp the ideas conveyed by "standing-by" and "running costs." A very good analogy is furnished by the recent action of a Metropolitan Borough Council in connection with wash-house charges or the rates levied for the use of the public wash-house accommodation. The value of the illustration is enhanced by the conditions being reversed; in electricity supply, the undertakers desire to encourage long-hour loads; in the use of the wash-houses the owners, having established them at public expense for the benefit of the very poorest classes, are anxious to discourage the locking-up of the facilities in the hands of a few, which would thereby prevent the utilisation of these public conveniences by the many. The intention of any such rate of charge is to make it difficult (by making it costly) for washer-women to stick to the premises for long hours together, doing work not for their own families but for others. A sliding scale has been in use in the case in point for some time past as follows:—

First hour.	Second hour.	Third hour.	Fourth hour.	Fifth hour.	Sixth hour.	After, per hour.
1d.	1½d.	2d.	2d.	2d.	2d.	6d.

This scale, however, was not found to increase the charge after the third hour at a sufficiently rapid rate to meet the local conditions, and after consideration of the advisability of slightly raising the charges, the opinion was expressed that they should be altered in this manner:—

First hour.	Second hour.	Third hour.	Fourth hour.	Fifth hour.	Sixth hour.	After, per hour.
1d.	2d.	2d.	3d.	4d.	5d.	6d.

Here we have the demand principle in full operation in the supply of an entirely different commodity to electricity and for rather different reasons, although the effect to be created is precisely similar in kind but opposite in direction. What is desired is the bringing into play of the economical propensities of the purchaser by making the commodity expensive at the time when the supplier does not desire to encourage the demand. The public wash-houses are established with a definite end in view and lock up a large sum of public money, and they are run at a loss, cheerfully borne, because of the sanitary amelioration in the conditions of life of the humbler classes; the rates for the times during which such classes may advantageously make use of them are almost nominal, but an artisan's family washing cannot require more than three hours to accomplish, after this period, therefore, the rates rapidly rise to a figure

deterring the user from continuing in possession. The proposed increase of one halfpenny in the charge for the first three hours—which is about the average time taken by the washers—is estimated to increase the former takings by 10 per cent., while the increases in the charges beyond the third hour are not, it is considered, likely to affect the class for whom these institutions were primarily established.

While on this subject we would suggest that instead of enunciating the tariff on the maximum demand system in the usual way—for example, "7d. per unit for the first hour's use of the maximum demand, and 1d. per hour afterwards"—it might be stated in the form of a sliding scale, somewhat as in the case above referred to. Thus, we should have, instead of the 7d. and 1d., the following scale :—

For 1 hour's use of the maximum demand				7d.	per unit.
„ 2	„	„	„	4d.	„
„ 3	„	„	„	3d.	„
„ 4	„	„	„	2½d.	„
„ 5	„	„	„	2⅕d.	„
„ 6	„	„	„	2d.	„

and so on.

This would leave no room for ambiguity, and the rather alarming sound of the 7d. is toned down by the subsequent soothing 4d.—2d.

If another analogy were wanted, we might point out that the postal tariff is of a similar nature to the maximum demand system, the only essential difference lying in the fact that it is intermittent instead of continuous, fractions of a pound (in the case of parcels) being reckoned as pounds. The tariff is :—

For 1 lb.	...	...	...	...	3d. per lb.
„ 2 lbs.	...	...	...	...	2d. „
„ 3 lbs.	...	...	...	...	1⅔d. „
„ 4 lbs.	...	..	...	...	1½d. „
„ 5 lbs.	...	...	...	...	1⅖d. „
„ 6 lbs.	...	...	...	...	1⅓d „

This is the sliding scale equivalent to a charge of 3d. for the first pound and 1d. for every pound afterwards, and represents a fixed sum of 2d. for standing charges on each parcel, and a running rate of 1d. per lb., according to weight.

Like most analogies, this is not perfect, and must not be pressed too far, but it may be of use in explaining the principle to puzzled and suspicious consumers.

Industrial Conference.

On Saturday, March 22nd, a conference, organised by the Labour Association, was held in Bradford to promote co-operative production based on the co-partnership of the worker. Three papers were discussed, which, whilst bearing different titles, such as "The Crisis in British Industry," and "The Efficient Organisation of Industry," were all based upon the same theme, viz. "Co-operation."

The authors of the papers were unanimous in the opinion that co-partnership offered a solution of the industrial problem. None of them, however, appears to have indicated the lines on which such co-partnership might be practically carried out. There is nothing new in the crude idea of co-partnership, but there are difficulties, and in some cases apparently insurmountable difficulties, in formulating a satisfactory scheme. Wherever it is possible to use labour-saving machinery, the proportionate cost of labour to the value of the finished article or machine can be so materially reduced, that the more general adoption of such machinery will make employers less and less inclined to take the initiative in any co-partnership proposal.

It is only in cases where the cost of labour forms a considerable proportion of the total costs of production, that there is any inducement for the employers to offer the workmen a share in the profits. On the other hand, the Trades Unions, as shown by the discussion on the above-mentioned papers, and by the expressed opinions of their officials, strongly oppose any profit-sharing proposals, and by their "ca-canny" methods are forcing the more extended use of labour-saving appliances. One speaker defended the "ca-canny," or restriction of output system. He said that unionists were opposed to being overworked and brought to an early grave, and had shown "how to work and prolong life." This is a somewhat novel claim for trades unionism, but we do not find that the speaker produced any figures to show that unionists were longer lived than their free labour brethren. Mr. Vivian, the secretary of the Association, voiced the feelings of all fair-minded men in saying that a man who did not put his best into his work was an enemy to his class. Resolutions were adopted expressing the need for conferences of the representatives of capital and labour in the great manufacturing centres. The objects of this Association appear to be almost identical with those of the National Industrial Association, founded last year by Mr. John Lockie, and discussed at some length in our columns.

Electricity Works Statistics.

With this number of the Electrical Review, our readers will receive the second portion of our annual sheet of statistics regarding the electricity works of the United Kingdom. It will be at once evident that the sheet has been entirely re-organised and revised. In order to avoid the unwieldy and annoying dimensions to which such sheets are apt to grow, we have adopted smaller type, and at the same time have compressed the information into the least possible space. Further, seeing that for most purposes of reference it is immaterial whether a station is alternating or direct, in Scotland or in England, we have adopted a uniform alphabetical arrangement for the whole sheet, except in the case of the stations within the County of London, which are grouped on sheet No. 2. By this alteration we have at the same time overcome two other difficulties—viz., the increasing preponderance of direct over alternating systems, and the frequent occurrence of stations combining both systems.

We have to record our sincere thanks for their kind assistance to the Central Station Engineers, who have, almost without exception, willingly furnished the necessary data; we gather from remarks let fall in several of their letters that the reduction in size will be very acceptable to them, and we trust that both they and our other readers will find the sheets (which are printed on one side only) convenient and useful for reference.

Lastly, we wish to point out that criticism is the salt of friendship, and that we shall be most pleased to receive from our readers and earnestly consider all suggestions tending to the greater usefulness of the sheet.

Acetylene for Lighthouses.—In a consular report sent home by the U.S. consul at Stettin last autumn, an opinion given by the chief of the Imperial testing station for marine lights, which is situated near Stettin, is quoted in the following words :—"For lighthouses out of reach of electricity, and easily accessible in winter or summer, acetylene would render good service, although it can in no way be compared with electricity in reliability, on account of the many details which must be looked after when burning this gas. I prefer electricity. Most of the French coast lights are electrical, while our lights are all petroleum." The consul proceeds to remark:—"At the Altenbruch lighthouse, on the Elbe, there have been some experiments with acetylene, giving the following results: By a consumption of 102 litres per hour 302 c.p. was produced, and by 175 litres per hour 435 c.p. An objection to acetylene for 'long-range' lighthouses, as advanced by an experienced sea captain, is that in a fog or thick weather it 'walls' too easily. A petroleum light will penetrate a fog to a greater distance than any other illuminant. For clear weather acetylene probably gives the best results. In this district (the Oder river down to Ziegenort) there are 15 navigators' lights, five of which are burning acetylene; one (on an artificial island in the Big Bay) is to be replaced by electricity, due to the difficulty of approach during the period of ice. Mariners have made considerable complaint about the weakness of the Arcona light (north-point of Rügen Island), and it is at this station that the Allgemeine Carbid und Acetylene Gesellschaft expects to erect its first permanent coast light."

CIRCULATION IN WATER-TUBE BOILERS.

By Wm. H. BOOTH.

The following notes are written in the hope of presenting a plain and practical explanation of the phenomenon of circulation in water-tube boilers. Water expands by heat, but the coefficient is too small to be of any value as a cause of circulation of solid water. It is only when steam is formed that true circulation can be looked for, and it is the formation of steam that is at once the hope of certain forms of water-tube boilers and the despair of others which fail to recognise natural laws, and, recognising them, to compel their aid.

It is scarcely sufficiently recognised that there is a vital difference in principle between the circulation in the comparatively horizontal tubes of large tube boilers and the nearly vertical tubes of the small tube type.

In a flatly inclined tube the steam, as it is formed, soon rises to the upper side of the tube, and in a lightly worked boiler makes its way along that to the outlet point opposed by the resistance of the water. In the small tube variety the steam cannot escape in this way, but remains mixed with the water in bubbles, or collects into plugs, and the result is a tube only partially full of water, capable of exerting a hydrostatic pressure very much less than if the tube were solid with water. If the down-comers afford a free flow of water to the lower ends of such a tube, the difference of head will produce a rapid circulation. In order to understand to what extent this action will take place, we need only take an actual example, and find what must really occur. We will assume the case of a water-tube boiler with tubes averaging 5 ft. in length, and of an inside diameter of 1¼ in. and an outside of 1½ in. The coal consumption will be taken at 60 lbs. per square foot per hour, and the evaporation 10 lbs. of water per pound of coal. The ratio of tube to grate surface will be 45 : 1.

From these data we first deduce that the weight of water evaporated being 600 lbs. per hour per foot of grate represents 13·33 lbs. per superficial foot of tube surface. As the surface of a 5-ft. length of tube is nearly 2 sq. ft., this is practically equal to 26 lbs. of water per tube per hour, or ·0072 lb. per second. The water contents of the tube is 2·6 lbs., or 0·0426 cub. ft. Thus in every second the tube is emptied of $\frac{1}{360}$ of its contents, or $\frac{1}{6}$ in. of its length.

If the boiler pressure be taken at 200 lbs. absolute, at which pressure 1 lb. of steam occupies 2·27 cub. ft. of space, the evaporation per second, or the volume of steam generated in the tube, will be ·0163 cub. ft. per second, occupying, say, 23 in. length of tube. Thus nearly half the length of the tube is filled with steam in each second of time, and the rate of flow equal to this head of water, H, is expressed in feet per second as $v = 8\sqrt{H}$, where H is in this case nearly 2 ft. v thus becomes 11 ft. per second. But as the feed water has been found sufficient to fill only a sixth of an inch of tube this flow is 782 times the feed, and, of course, could not continue, because the head due to space occupied by the steam would be reduced by the same proportion. Let the difference of head be reduced to 12 in. Then $v = 8\sqrt{1} = 8$ ft. per second velocity of flow due to a head of 12 in.

This rate of flow would empty the tube of water in $\frac{5}{8}$ second, so that the flow of water now is practically 576 times the feed rate. If the rate of flow were to fall off from this the volume of steam would quickly increase in the tube, and the velocity of flow would increase, whilst any further increase of velocity would be checked by the reduction of volume of the steam in the tube, and a balance would soon be struck. Even with these figures, however, it appears that there would always be 14⅜ in. of steam in the tube, so that actually the velocity of flow due to head must be somewhat more than that calculated. A balance would be found at about 13 in. of head, which would give a velocity of 9 ft. per second, or 648 times the feed, as shown below.

In the particular case in point for a 5-ft. tube in which 23 in. of steam are generated every second, the relative length of water and steam at any instant in the tube will, of course, vary with the velocity. For a velocity such that the tube is emptied in 1 second, the steam will, of course, occupy the length, 23 in.

The head causing velocity will be reduced as v increases, and must always be $H = \left(\frac{5}{v} \times \frac{23}{12}\right)$ ft. But v must always equal $8\sqrt{H}$, whence is obtained $H = \left\{\frac{5}{8\sqrt{H}} \times \frac{23}{12}\right\}$, or $\sqrt[2]{H^3} = 1{\cdot}2$ ft. ∴ H = 1·13, and as $v = 8\sqrt{H}$, we find v = 8½ ft., or 102 in., being 612 times the feed supply of $\frac{1}{6}$ in. Mr. Thorneycroft has claimed that he gets a circulation of 100 times the feed, and the claim seems moderate, even after allowing for the frictional resistance of the bent tubes of the boiler, but he or others claim that this is double what is obtained in drowned-tube boilers.

If, however, in either case the result is several times less than calculation would lead us to suppose possible, it must not be forgotten that the reduction of velocity implies a greater length of steam in the tube at any one instant, and this, of course, ought to add to the velocity by increasing the virtual head, H, causing flow. A velocity of 100 times the feed supply would, in the case under consideration, lead to the conclusion that in the 5-ft. tube the flow is only 16 in. per second, or one-third of the tube length, whence it would be supposed that such a tube would be nearly full of steam. But this view would be modified when it is considered that the evolution of steam would be chiefly in the upper ends of the tubes where the water is hottest and there is least hydrostatic pressure.

In any case it is probable that the circulation in small tube boilers is likely to be considerable, and there ought to be ample area of down-comer to allow of supply. There can, of course, be no circulation whatever unless there is a supply to the base of the tubes. Thus, in the case of a boiler with 5 ft. tubes, if the grate area were 20 sq. ft., there would be 450 tubes evaporating 1,170 gallons per hour. If 600 times the feed had to pass the down-comers, provision must be made to pass, say, 600,000 gallons through the down-comers every hour, which at a flow of 5½ ft. per second, would call for four 15-in. pipes. Such provision is not made. Probably it is an unnecessarily liberal provision for a grate area of 20 sq. ft., but it is also probable that more rapid circulation would be secured with even more liberal allowance of down-comer area, and that even Mr. Thorneycroft's claim of about 100 times the feed as shown by measurement in the down-comers may be as moderate as it is, because of the area provided being no greater than it is.

Now let us examine the Belleville boiler of which we have heard so much. An element of the boilers of the *Diadem* measures about 106 ft. in length in 16 folds, and is heated by about 5 sq. ft. of grate area, burning 21 lbs. of coal per square foot, or, say, 1 lb. of coal per hour for each 1 ft. length of tube. Allow an evaporation of 9 lbs. of water, and this gives 95 gallons per hour per element, or, say, 15 cub. ft., representing 2,140 cub. ft. of steam at 200 lbs. absolute. As most of this steam is made in the lowest lap of tube, there is an equivalent plug of steam to get away every second, no less than 7 ft. long (if we assume the tubes to be 4 in. inside diameter). Assume that of this amount 3 ft. in length is generated in the bottom lap of tube, and the picture can be imagined of the condition of each element with, every second, a plug of steam 3 ft. long struggling up the 16 folds of pipe with their 30 bends, gradually growing in length to 7 ft. as it nears the steam drum. By intention there is no water circulation in the Belleville boiler, and this steam is not intended to carry with it any water at all.

It is only too obvious that it must and will carry much water, and this will suffice to explain why the bottom tubes become red-hot from lack of water, for it is easy to understand that very little fresh water can sometimes enter at the nozzles. It is also easy to see why the back-pressure valves were placed in the down-takes, for these would naturally form the easier and shorter way for the escape of steam from the bottom tubes. It also becomes clear why the Belleville boiler is worked at so high a pressure, so very much in excess of that at which the engines are worked. With a pressure of 300 lbs. absolute, the 7 ft. length of steam plugs at 200 lbs. would be shortened to 4 ft. 8 in., a very material difference, and one that at moderate rates of coal con-

sumption enables the Belleville boiler to give for a time apparently satisfactory results. At the same time, the length of steam plugs generated per second, and the certainty that with a little harder pushing some of the tubes will surely become emptied of water, exercise a certain effect on the minds of such of us as still cling to an old-fashioned objection to red-hot boilers, and to the belief that an efficient navy is a better safeguard than the goodwill of continental Europe.

The idea that water should flow into the bottom tubes through the nozzles and back-pressure valves in a regular stream appears quite contrary to reason. When the tubes are generating steam in large volumes, this steam pushes the water before it. The water receives a severe check at each of the 30 bends in an element, and it is quite likely that at times the pressure of steam in the bottom tube is greater than the pressure at the foot of the down-comer, thus preventing the injection of fresh water into that element. It is extremely probable that the elements become dry from time to time. As soon as an element becomes dry, its excess of pressure at once disappears, and fresh water no doubt then freely enters the lower tube again, at first flashing into steam as it enters the now red-hot tube, and gradually filling the element to the normal water level.

This action will account for the fact that often the water disappears from the glass gauges. There are not water gauges on every element in a boiler, and it can never be known how frequently some or other elements are dry. Probably every element is dry as often as is the element which carries the water gauges, and it would be strange, indeed, if the lower tubes did not become red hot at times, and overhot frequently.

It is thus certain that no such action can be set up in the long flat-laid tubes of the Belleville boiler, as occurs in the small high-pitched tubes of the small tube boilers first considered. The difference of head is only about equal to that of the small tube type, while the resistance to circulation is enormously greater, more particularly because of the numerous sharp bends. The size of the tubes also renders less perfect the plugs of steam, and there is some tendency for the steam to lodge against the upper surface of the tubes. Indeed, this may probably be the cause of the upward hogging of the tubes that is so noticeable a feature of the two lower laps in each element of Belleville boilers.

Reverting to the small tube boiler in respect of the difference between the calculated flow and the claims made, it should be remembered that the calculated flow will be reduced to nearly half the calculated amount if the contraction coefficient due to parallel orifice be taken into account. The flows into the various tubes will interfere one with the other. The water also approaches the tube openings in an unfavourable direction or across the tube openings. These points and the friction of flow in long tubes combine, no doubt, to explain why flow is perhaps several times less than might be expected at a first glance at the figures involved.

In most water-tube boilers of the small tube type the furnace is bounded by a wall of tubes, and by far the greatest evaporation must occur in these more exposed tubes. Both the Yarrow and the Thorneycroft boilers are thus arranged, as also the Reed, Seaton, Blechynden, Leblond, and others. In the Weir boiler the furnace wall tubes are cased in fire-brick for reasons of combustion and smokelessness, and the evaporation is thereby much reduced in these few tubes. The hot gases in the Weir boiler, after escaping from the combustion chamber, travel in the direction of the length of the tubes, thus heating every tube fairly uniformly. Where any particular row of tubes in any boiler is so placed as to be more severely heated than others, especially if there is any sign of distress or overheating, it would probably be found advantageous to introduce at the lower ends of the tubes conical mouth-pieces of thin drawn brass so as to facilitate the inflow of water. Thus for a tube of $1\frac{1}{4}$ in. diameter, a mouth-piece of $1\frac{5}{8}$ in. would probably give the maximum flow possible, assuming a *vena contracta* of 0·6. In the Yarrow and some other boilers the large evaporation of the more heated tubes leaves so little for the rear tubes to do that they become down-comers, and the tubes automatically divide themselves into up or down tubes. The down-flow tubes are equally effective, as though the flow in them were upward, but down-flow is only caused by the action of the steam in the up-flow tubes. When down-flow has once been established it tends to continue, because though the water is receiving heat it is travelling toward a position of greater pressure, and steam is thus less easily formed than in an up-flowing current where reverse conditions prevail. Most constructors, however, prefer large and separate down-comers, and in the Weir boiler, where the duty of evaporation is so well distributed among all the small tubes, the separate down-comer is essential. There is, however, no absolute necessity to keep these down-comers outside the furnace or heating space. Being large and with only a small surface per unit of water contents, they will not readily become steam generators, and will always act as down-comers.

Circulation of water, due to altered specific gravity by added heat, is only sluggish when steam is not formed, and this factor should not be expected to produce much current.

In the flue feed heater or vertical pipe economiser it is probable that specific gravity does come into play in proportioning somewhat fairly the amount of water flowing up each tube according to the heat position of the tube, the most water passing up the tubes nearest the boiler. But the specific gravity effect in a boiler is very small indeed after a boiler is once heated up, and can hardly be claimed to exist outside a feed heater. The only gravity effect in a boiler is that due to the steam bubbles in the water. The mixed mass is reduced considerably in weight, and is rapidly pushed upwards by solid water descending the down-comers. Circulation of this kind is simply a question of weight, and does not depend much on the so-called entraining action of the steam. The water carries the steam along with it quite as much as the steam carries the water.

While it is convenient to assume that the steam and water in a vertical tube are arranged as alternate plugs, it by no means follows that such is the case. The tendency for steam to separate from the water is greater in flatter tubes, because so small a vertical movement of a steam bubble will place it above the water, and near the top side of the tube. In struggling forwards against the resistance of the water there is then a tendency for the steam to become a plug, and when this occurs the whole of the water in front of the plug may be projected from the tube into the steam drum; this seems to be the regular mode of action in the Belleville type of boiler, and to explain the frequent dryness of the water gauges. A careful consideration of the circumstances of a water-tube boiler and a simple calculation of a special case will often serve to point out the probable results of any boiler. In this way the behaviour of a type may be estimated; and there can be little doubt in the mind of anyone who will trouble to make such simple calculations whether a boiler is constructed on sound principles or not.

The few figures given above are amply sufficient to show the soundness of principle of the vertical small-tube type of boiler, and the unsound and dangerous nature of long tubes of the flatly inclined type, an unsoundness that is intensified in the case of the Belleville boilers by the multiplicity of bends.

In fitting the Belleville boiler with down-comers, recognition is given to the fact that the steam when escaping from the tubes carries water with it. In such a boiler, owing to the great mass of water in the tubes, and the small amount in the down-comers, the easier way of escape for the steam was by way of the down-comers. To prevent this ill behaviour, the down-comers were fitted with non-return valves, and these have simply formed so many abutments against which steam, formed in the lower tubes, has obtained the thrust necessary to expel the whole of the water from the tubes, and enable them to become red-hot at frequent intervals.

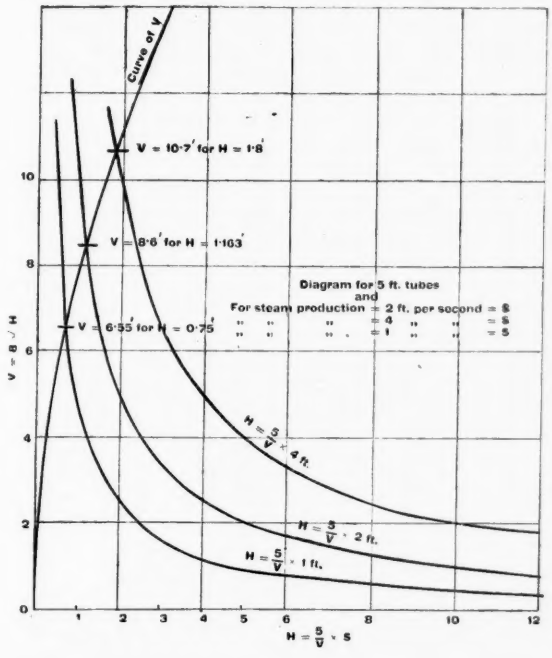
Were it absolutely essential that such a boiler as the Belleville should be made to work, a lesson might be taken from the small-tube type of boiler, and such an absolute and positive mechanically-produced circulation adopted as would put through the tubes one hundred times the amount of water that is pumped in as feed. We might then see the circulation in a downward direction with advantage. The circulation of a large boiler with an equivalent head of 2 ft. would require $\frac{1}{8}$ H.P. net, so that in any case the power required would not be serious, and almost any boiler would be safe under such conditions, whereas it is impossible at

present to see how, in any other way, a boiler of long-tube flatly inclined type can be other than dangerous.

If the circulation of 100 times the feed supply be accepted as a practical fact, this represents, as we have seen, a velocity of 16 in. per second through each tube. To this must be added the length of 23 in. of steam plugs, giving a total velocity of 39 in. per second to the water plugs in order that a net 16 in. of solid water shall escape. The figure 100 was only determined by measurement of the flow by the down-takes, and therefore represents the mean value of the circulation in all the tubes. We can hardly doubt the more rapid flow in the more heated tubes, whereby these are maintained cool, though it will still remain advantageous to assist water to enter these tubes in the way above described. Incidentally, a study of the problem leads to the conviction that where the feed water is put into a boiler at a temperature less than that of the boiler it should not enter the lower drums but the upper. The effect of putting the cooler feed into the lower drums is to cool the whole water or tend to cool it below the temperature of evaporation, and the result of doing this will be that steam will not be formed in the lower ends of the tubes, but will only commence to be formed some more or less distance up the tubes, thereby reducing the intensity of circulation. We refer here, of course, only to boilers of vertical tube type.

The effect may not be very serious, but there are other advantages connected with the entry of feed water at the higher level that make it desirable to select that point.

The annexed diagram shows how the velocity of flow may be graphically determined for any rate of steam production. Three curves for H are drawn, representing the production


Curve of V
V = 10·7′ for H = 1·8′
V = 8·6′ for H = 1·163′
V = 6·55′ for H = 0·75′
Diagram for 5 ft. tubes and
For steam production = 2 ft. per second = S
" " " = 4 " " = S
" " " = 1 " " = S
V = S / H
H = S/V × 4 ft.
H = S/V × 2 ft.
H = S/V × 1 ft.
H = S/V × S

of a length of 1 ft., 2 ft. and 4 ft. per second of steam plugs in tube. The theoretical velocity of circulation for each case is given by the intersection of the curves with the curve of velocity.

The diagram is for tubes of 5 ft. vertical difference of height between upper and lower ends, and it shows how the theoretical circulation differs but little for evaporation rates from 1 to 4 ft., the evaporation being stated in linear feet of tube occupied by steam per second, while the actual circulation per tube for different rates of evaporation probably differs still less. Thus where the rate of flow per second is one tube length, the length of tube occupied by steam is S. It is important to grasp this, because upon it depends the whole principle of the small tube boiler. In large tube boilers, even of the better types, the entry of a number of tubes into one header, the cross-sectional area of which is much less than the joint cross-sectional area of the tubes which enter it, must have a very deterrent effect upon the rate of flow, and, unfortunately, the lowest tubes which produce the most steam and demand the most rapid circulation, are subject to the greatest obstruction to flow through them, while the motive power of circulation is reduced by the effect of the upper tubes discharging to the same header. The same remarks apply in modified form to the down-comers of these boilers, for not only do they bring down the water to be most convenient to the upper tubes that require the least supply, but they have a total area of cross-section only a fractional part of the area of the tubes they feed. If, therefore, the circulation is to be even moderate in the heated tubes, it must be very rapid in the down-comers, and in any case there is introduced the objectionable principle of greatly varied velocity of flow during the progress of a complete cycle of circulation.

In respect of the principles and action of circulation in water-tube boilers, the conclusion seems inevitable that the small tube, nearly vertical type, is distinctly and decidedly superior, and that large tubes of flat inclination, especially when long, and with many bends, as in the Belleville type, are absolutely dangerous and unscientific, unless provided with mechanically-propelled circulation, so certain and positive, as to compel a sufficiency of water to pass through the tubes, not merely as a whole, but individually as regards each element—a complication only perhaps to be justified when applied to existing boilers, and not to be taken as justifying the continuance of the type.

A MUNICIPAL EXPERIMENT.

Is it too late to ask once more by what right any municipality undertakes something which is, essentially, or in the nature of, an experiment? Considering the best aspect of the case, considering, that is to say, an aspect which has not hitherto developed, when a real majority of the ratepayers—not merely a majority of the Council—of a town, have undertaken an experiment, can it be said that they have any moral, or political, right to do what they have done? With a liability which is unlimited, with an undeniable call to consider posterity, have they the shadow of an excuse for plunging into a scheme of any description, which is either absolutely untried or, perhaps, has been worked successfully under very different conditions? In our conception there can be only one answer.

The question before us is not one of the equity or otherwise of municipal trading, or the expansion of local governing powers, it is simply and solely the question of the morality of risking the welfare of a community, and of the descendants of a community, by undertaking something, the very working of which is not assured, of which it can be said only that *probably* it will be successful. "Probabilities" are for private enterprise; nothing but "certainties" should be touched by the community.

This little homily has been suggested by the action of the Wolverhampton local authorities in the matter of electric traction within their boundaries. Certain lines running into the town from both sides were, as is tolerably well known, served by steam and horse cars owned by a local company. Connections were made by these lines with the intricate network of tramways in the surrounding Black Country. In the course of time the lines within the Wolverhampton boundary fell into the hands of the town, cut down by the ruthless shears of the Tramways Act of 1870. Not only did the Corporation refuse to grant a lease, they turned out the company bag and baggage, and scouted the idea of sanctioning running powers under any conditions whatever. As a consequence Wolverhampton has been free from the noise of trams for something like two years, and communication with the outer barbarians has either ceased or has maintained a flickering life by means of daily and decrepit omnibuses. (We understand that within the last month or so a gleam of sense has been forced into the Council chamber, and a temporary running agreement, not conferring any fixed powers, has been entered into between the company and the Corporation.)

One day a gentleman walked into the Town Hall and produced from his waistcoat pocket the model

of a mighty fine surface contact system. To supply the place of the suppressed trams, a Tramway Committee had been formed, composed of the usual number of experts in tramway matters found on these committees in most towns. He introduced himself to the Committee, and impressed a majority of them with the notion that the Wolverhampton air was especially suitable to such a system as his, although it did not appear that it had had any particular chance of showing itself to the world in practical and long-continued working.

There were a considerable number of members who were not expert enough to see the evident advantages of the system over the commonplace trolley system surrounding them, or about to surround them, on all sides; and they were not converted even by the exhibition in the Town Hall of a full-sized contact box flicking in and out a few real glow lamps as a real electro-magnet was energised and de-energised.

Nevertheless, the Lorain Company's agent departed with an agreement. Under the terms of this document the Lorain Company were to be permitted to build a mile of track equipped with studs as an experiment. If the system did not fail within 30 days, the company were to be allowed to equip the remaining 11 miles of proposed tramways.

After considerable delay on account of the difficulty in obtaining contact boxes from America, the mile was finished, and was inaugurated with a certain flourish.

It was very noticeable, however, as the 30 days' probation waned, that the unfavourable minority did not show any signs of conversion, and there were such general signs of wavering throughout the Council, that it was decided to call in an expert, who should bless or damn the system by a report. (Our readers will remember that it was stated in our issue of February 14th last, that the expert was called in on account of stoppages which occurred on three consecutive days, caused by the snow.) The report, together with a supplementary report by the borough electrical engineer, is published in abstract in our columns to-day.

We gather from the abstract that the only good things to be said of the system are that the probability of the studs remaining alive after a car has passed is extremely remote, that the mechanical strength of the contact boxes and permanent way is sufficient, and that the leakage is not excessive. With regard to the last point we confess to agreeable surprise. It is stated that the mean leakage to earth is nearly ·01 ampere per mile, *whether the cars are running or not*. Presumably this result is the mean of tests taken frequently over the whole 30 days, which included much bad weather, resulting in the streets being covered with snow, slush and mud. We do not doubt the accuracy of the figure, but shall be much surprised if it can be maintained. Under abnormal conditions, *i.e.*, with the road surface saturated with salt, the leakage rose to as much as 10 amperes *per car*, so that the suggestion of the expert that salt should be used as infrequently as possible is not superfluous.

Our first impression of the studs, viewed as obstacles, was not very unfavourable. They are spaced with 10 ft. centres, and project sufficiently to be rather annoying to horses. The skates themselves are furnished with twelve magnet coils, wound with shunt and series turns, the shunt being connected across the stud and rails, and taking 1·9 amperes at 500 volts, while the series takes the motor current. The latter is not of much account, but the shunt watts are most important. It has been shown often enough that the average current per four-wheeled car varies from 10 to 15 amperes according to the nature of the road, so that the constant magnetising loss will be between 13 per cent. and 20 per cent. of the total. This is nearly as much as would be necessary to run electric car heaters, and means that if over the 12 miles of track 50 cars are run, a 50-KW. set will be required to pick up the current. In addition to this direct loss, there is another which must amount to something like the same figure, and this is the loss due to the friction between the collecting skate and the studs. That this is not insignificant may be gathered from the report, which mentions that the life of this heavy strip of phosphor-bronze is between 300 and 400 car-miles. It has been suggested that the sweepings from the track might be made to pay a dividend if the metallic dust was separated.

We imagine that the collecting skate costs much more than 2s. 6d., the price of a trolley-wheel, and as it does not last one-tenth of the time, the renewal item will be very serious. The sett paving was not done extraordinarily well, although under the supervision of the town, but it is much better than a large number of lines within our knowledge. Nevertheless, considerable trouble has been experienced already through the skate being held out of contact by a high sett, or by its own deformation, and it seems to us that it will be necessary to line up the whole track with a straightedge every night if perfect running is desired. An overhead trolley wheel is able to adapt itself to the wire even when the vertical height of that wire varies 8 or 10 ft., but the vertical movement of the skate has to be confined to less than $\frac{1}{2}$ in. If it is $\frac{1}{32}$ in. too high, it will not make contact; if it is $\frac{1}{32}$ in. too low, it will commence to plane the roadway, and to rip strips from itself.

Is it conceivable that, after a few winters, or, perhaps, only one, when the track has become more or less waterlogged—as tracks do where the traffic is very heavy and weather severe—is it conceivable that the levels of the boxes and of the setts will be anything like accurate enough for this promenade system?

In whatever direction one turns, a comparison between the running expenses of the overhead system and of this is unfavourable to it.

In order to energise the magnets when starting from the sheds, or after losing contact on the road, a heavy battery has to be carried *and maintained*. These batteries are charged at night in the sheds, and, of course, require handling and supervision.

In the towns of the Black Country, many carts containing scrap iron meander through the streets, dropping chunks of iron on all sides, which remain long enough to make themselves objectionable to cyclists and others. While the cars are running no danger need be apprehended, for the magnets will most likely collect all the iron within their reach, the accumulation being deposited at the termini. It is rumoured that the rates will be reduced—at present they are nearly 9s. in the £—by the profits arising from the sale of the collected scrap.

Unfortunately, this same scrap has a way of short-circuiting the line when it gets between the skate and the motors, or ironwork of the trucks; but both the expert and the engineer say that they do not consider these frequent shorts of any practical importance. We wonder how many station engineers would be so indifferent, especially if the machines under their charge were liable to flash round or to the frame, on a "short"; and, more especially, if the station combined lighting and traction, and ran balancers or motor-generators off the traction bus bars?

The expert calls attention to the possibility of trouble arising through water finding its way through the seal of the contact box, and so destroying the insulation, and states that time only can prove whether the jointing material will keep the box tight. He expresses also his opinion that the cables joining the boxes should not have been laid in the centre of the tracks.

Some of the figures given by the engineer are instructive. The passengers carried and money earned are of little importance, as these figures are always abnormal on the opening of a new line. In 30 days 2,364 round trips were made, and 110 round trips, or 4½ per cent., were lost. It must be remembered that during the whole of this period, the exploiters of the system have been buzzing round the mile of track like diligent nurses, and that everything is new. It may be taken for granted, too, as so much depends on the success of the system, that everything was in apple-pie order when the real trial began; yet, with all that, 4½ per cent. of the possible journeys were lost. What then may we expect when the whole of the lines have been running for some time?

In the sequel, expert says:—"I wish it to be distinctly understood that I do not claim to have exhaustively investigated the Lorain system, or to be in a position to predict its ultimate success or failure. I do not think that it is possible for any expert to attain such a position by looking at the system for something less than 30 days. I have called attention to all the points which have presented themselves, and I have . . . . have not been able to discover any inherent defects which should prevent the Corporation from authorising the contractors to complete the equipment of the

remaining 11 miles of route. . . . . I consider that the utmost care, and most careful observation . . . . during the succeeding 12 months' trial of the system will be necessary, in order that a definite conclusion may be arrived at by the time that period has elapsed. *I regard the period of 12 months as being all too short for a complete investigation into the practicability of any surface contact system*, beset with difficulties as it undoubtedly is." (The italics are ours.)

The engineer says:— . . . . . "I wish it to be distinctly understood that this report, together with all facts, figures or opinions expressed therein, relates solely and entirely to what has occurred during the 30 days' trial which has just expired, and is not intended to deal in any way with the general question of the ultimate success or failure of the system." That immediately succeeding this sentence reads rather queerly:—". . . . I am of opinion that the Corporation are quite justified in instructing the contractors to proceed with the equipment of the remainder of the 11·375 miles of single track."

It may be interesting in this connection to quote the following passages from the Electrical Review of May 10th, 1901, p. 808:—

> Mr. Shawfield, the city electrical engineer, in a letter to Mr. Alderman Mander, said that he could not as a professional man take the responsibility of advising the Council to definitely adopt this system in preference to the overhead system, as this course would commit him to a responsibility for the success of the system which he was totally unprepared to take, without having first seen the system in operation under working conditions for at least one year. . . . .
>
> Alderman Mander also stated on the question of expense that the cost of the Lorain system would amount to £24,500 more than the overhead system, and the extra cost per year with regard to repayment would be £1,155. The company, he added, were offering the Corporation to lay down at their own risk and cost a line which would be equal to £20,000 or nothing, and that was quite good enough for him. He therefore moved a resolution in favour of the adoption of the Lorain system of traction, and after considerable discussion it was carried by 23 votes to 14.

Again, in our issue of February 14th last, p. 260, will be found the reports of Colonel Yorke and Mr. Trotter to the Board of Trade. Colonel Yorke, after referring to the likelihood of the contact plates becoming "a source of inconvenience, and possibly of danger, to vehicular traffic," said "it is to be hoped that my fears will not be verified. For the present I can recommend the Board of Trade to certify the track . . . . as fit for traffic, and . . . . to authorise the working of the line by electrical traction on the Lorain Surface Contact System for a period of 12 months." Mr. Trotter said "as there is no experience in the use of this system . . . . I recommend that sanction be given for the working of this system for 12 months."

Surely, further comment is needless.

THE PHASE DISPLACEMENT OF ALTERNATORS AND PARALLEL RUNNING.

By H. C. LEAKE, A.M.I.C.E.

The action of alternators direct coupled to prime movers when running in parallel with one another, and with or without synchronous machinery, depends on a number of conditions. In this article it is proposed to deal with only one of the factors which influence parallel running, namely, the effect of periodic fluctuation of the turning moment of the prime mover, such as is inherent in reciprocating steam engines, and no consideration is given to the influence of other factors, such as the effect of engine governors, &c.

In order to secure satisfactory parallel operation of alternators direct coupled to prime movers with uneven turning moment, it is commonly held that the phase displacement of each generating set must not exceed a certain amount, depending on the character of the load. The largest phase displacement is allowed in the case of a non-synchronous load, less for a load of synchronous motors, and still less when the load includes rotary converters. For instance, Mr. Eborall stated in his recent paper before the Institution of Electrical Engineers that, in this latter case, the phase displacement should not exceed 2°, by which is meant that the wave of E.M.F. (electromotive force) of the alternator must not differ in phase by more than 2° from the wave of E.M.F. which would be generated if the rotation were perfectly uniform.

Having fixed on the maximum phase displacement permissible and the number of poles and the revolutions, it is possible to estimate for any given type of engine what maximum speed variation may be permitted without exceeding the maximum phase displacement and to deduce the amount of moment of inertia required in the rotating parts. Specifications for engines for coupling direct to alternators usually state a maximum speed variation in the revolution which must not be exceeded, and, in some cases, it is stated that this is required when running on a load offering a constant torque, but when this condition is not explicitly stated it is, in so far as the author has observed, taken as implied, and all the methods of calculating the speed variation which the author has seen make this assumption.

It appears to be considered that such limitation of the phase displacement or of the speed variation during the revolution rests upon a rational basis, and is the condition demanded by theory in order to secure good parallel operation in so far as the cyclical variation of turning moment is concerned, and a calculation is given in text-books, &c., by which the maximum cross current for two alternators in parallel is derived directly from the phase displacement and the impedance of the armatures. Some time ago the author had occasion to look into this question, and came to the conclusion that the present method of proportioning the rotating parts is theoretically incorrect, and that there are no theoretical grounds for considering that, by specifying a definite small speed variation, good parallel running will be obtained. Consequently, the present method must be regarded as entirely empirical, and therefore data obtained from experience must be used with great caution when the conditions are changed. For instance, if certain sets of 500 KW. and 40 periods operate satisfactorily in parallel with a phase displacement of $2\frac{1}{2}°$, it is not correct to infer that 1,000 KW. sets at 25 periods will operate equally well if they are designed to have the same phase displacement.

The author called attention to this point in a contribution to the discussion on Mr. Eborall's paper, and proposes in the present article to go more closely into the question.

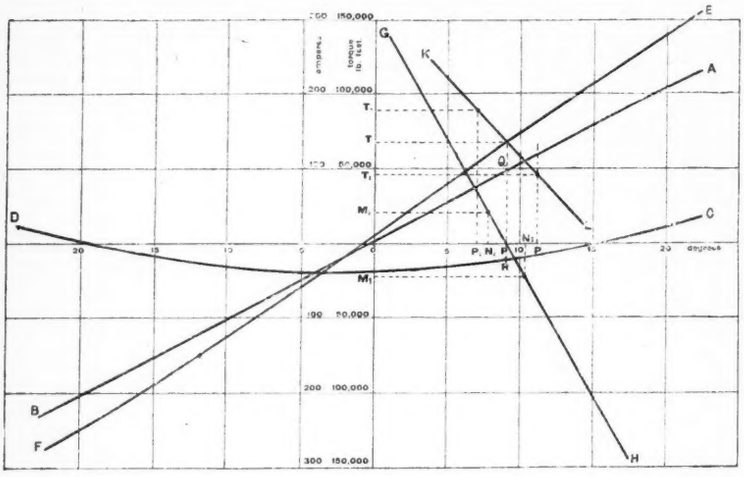
The usual argument given in text-books is in effect as follows:—Consider two similar alternators in parallel, and assume that at a certain moment in the revolution the position of one is in front of its mean position by the specified maximum phase displacement, and that the other is behind its mean position by the same amount, the meaning of maximum phase displacement being that given above. If the E.M.Fs. of the two alternators are equal, the resultant E.M.F. tending to send a cross-current is equal to the product of the E.M.F. of either machine into twice the sine of the maximum phase displacement. It is thence argued that by dividing the resultant E.M.F. by twice the synchronous impedance of one armature, the maximum cross-current in parallel operation will be obtained. It follows that the cross-current is proportional to the sine of the phase displacement, and to the short circuit current of the alternator. Hence, assuming a maximum cross-current, the maximum phase displacement allowable is deduced, and it appears to be commonly considered that if the moment of inertia of the rotating parts of the generating sets is so proportioned that this maximum phase displacement is not exceeded when running on a load offering a constant torque, then the assumed maximum cross-current will not be exceeded when operated in parallel with another.

Putting aside the question as to how far the self-induction and reaction of an alternator can be represented by a constant impedance under such varying conditions as required by the above reasoning, there is one serious error in the above argument, viz., it is assumed that the maximum phase displacement of a generating set when running in parallel is not greater than when it is running alone on a load offering a constant torque. This is far from correct, and though it may at first sight appear that interchange of power between the alternators in parallel must reduce the phase displacement, yet the author believes that such is not necessarily the case.

Although it is not possible to calculate exactly what will happen when two or more generating sets are run in parallel, yet some useful conclusions may be arrived at by studying the action of a set under theoretical conditions. The

analytical method of studying this subject presents many advantages, but in this article the author proposes to confine himself to an explanation of the action by a graphical method.

When generating sets are running in parallel in a theoretically perfect manner the P.D. (potential difference) between the bus bars will be perfectly uniform both in effective value and in periodicity. We will, therefore, in the first place, assume that such uniformity of the P.D. between the bus bars is actually secured and investigate the action of a single



generating set running in parallel with others under such conditions. It is assumed that the load on the bus bars is constant and the effect of damping is neglected.

In order to investigate this matter, we shall employ a set of curves which, so far as the author is aware, have not been described before, but which have proved most convenient in studying these questions. These curves have as abscissæ values of the angle by which the phase of the E.M.F. of the particular alternator in question is in advance of the phase of the P.D. between the bus bars, and this angle we shall denote by φ. The ordinates of these curves are the phasal component of the alternator current, the wattless component of the alternator current, and the driving torque of the alternator—the speed, the exciting current, and the P.D. between the bus bars being constant.

It would unduly extend the present article to enter upon the question as to how these curves can be determined by experiment or by calculation, but it may be noted in passing that when calculating such curves it is necessary to take into account separately the self-induction of the armature and the magnetising or demagnetising action of the current. Opportunities of conducting experiments such as these on alternators of the sizes which are common now are not frequent, and the author regrets that he is unable to give data obtained from an actual machine. For purpose of illustration calculated curves are therefore given instead; but it may be stated that such data of actual alternators as the author possesses show that the general shape of actual curves is similar to that deduced by calculation.

The diagram shows the calculated curves for an 865-KW. three-phase alternator as follows :—

Revolutions per minute	...	93·8
Number of poles	... ...	32
Periodicity per second	...	25
Full load (non-inductive)	...	100 amperes at 5,000 volts.

The resistance, self-induction, and reaction of the armature have been assumed at such values as will give the alternator the following properties :—

C^2R loss in armature at full load is	9 KW.
Inherent regulation when excited for a load of 100 amperes, at 5,000 volts, the power factor being 1, is	96 per cent.
Ditto, the power factor being ·8, is	84 per cent.
Friction, hysteresis, and eddies assumed constant at	45 KW.

The curves are calculated for an alternator E.M.F. of 5,500 volts and a bus bar P.D. of 5,000 volts.

Referring to the curves, the E.M.F. of the alternator is to be understood to be the P.D. at its terminals when running on open circuit, so that the E.M.F. depends only on the exciting current and the speed. The abscissæ of these curves represent the angle by which this E.M.F. is in advance of the P.D. at the terminals of the alternator when on load. The current yielded by the alternator can be, as is well known, considered as made up of two components, one in phase with the P.D. at its terminals, termed herein the "phasal component," and the other in quadrature with this, termed the "wattless component." Curves A B and C D represent the root mean square values of the phasal and wattless components respectively, the wattless current being taken as positive when it is in advance of the P.D. Curve E F represents the torque (measured positive in direction of rotation) which has to be supplied by the prime mover. The curves are extended to the left of the zero, so that by giving the various quantities algebraic significance the diagram serves also for a synchronous motor. The curves A B and E F, if extended far enough, each pass through a maximum and a minimum on the right and left of zero respectively.

If a steady torque, O T, is applied to the alternator, the diagram shows that the phase of the E.M.F. will be in advance of the phase of the P.D. by the angle, O P, and that the phasal and wattless components of the current will be P Q and P R respectively, corresponding to an output of 98 amperes at 5,000 volts with a power factor of 98 per cent. (lagging).

(*To be concluded.*)

CORRESPONDENCE.

Insurance Companies and Electrical Installations.

Insurance companies are gradually becoming somewhat unreasonable in their conduct towards electrical contractors. If they are asked to insure premises which have been fitted with an installation, they immediately send along a list of some 20 to 30 questions on a printed form, requesting that answers may be written in and signed by the contractor or his electrician. This may seem trivial enough at first glance, but as electric lighting and power becomes more general, and frequent extensions take place, often enough carried out by a totally different contractor, it assumes another aspect.

Recent cases have cropped up where extensions of insurance contracts appear to necessitate that answering another battery of questions by the contractor, after the contract for lighting, &c., has almost passed from memory. The same often applies to a change of insurance companies or to a change of tenant. This sometimes means a lot of work, turning up old accounts and examination of the installation in question, to see if any extensions by other people have taken place, and to find what condition the work is in. In many cases an insurance form such as is referred to cannot conscientiously be filled up and signed without this trouble.

Another phase of this subject is the responsibility incurred by the contractor, and whether or not there may be further trouble for him in a case where, perhaps, the installation has for years passed out of his control.

As insurance companies strongly object to pay for these services, but still insist, as far as they have power, upon having their work done for them, I think that there is a distinct grievance. Before, however, taking a decided step in the matter, I should like to have the opinions of others similarly placed.

Edward Rayner.

Newport (Mon.), *March 25th* 1902.

Test Wires in Cables.

I have often wondered why consulting and borough engineers, when specifying single conductor cables for lighting purposes, do not, at a little extra expense, specify two test wires instead of one, as is invariably the case.

When there is only one test wire, the only purpose it can be put to is for getting the potential at the end of the line, and it is no good whatever to use it as a lead for the loop method of localising faults should the cable break down; but if there were two, fault localisation would be rendered a simple matter.

In the case of heavy feeders for tramway work, should one of them earth there is no way of localising the fault, unless it be by the low resistance bridge method, and this is invariably rendered useless in large towns due to the inductive effect of neighbouring lighting mains; but if that feeder were provided with two test wires, the Murray loop test could be at once applied, and the fault located without delay.

In the case of tramway feeders, both test wires would be permanently connected to the end of the feeder in the disconnecting box where it feeds the line or rail, as the case may be.

This arrangement would ensure the insulation of the test wire always keeping perfect, as by joining it to its own conductor they would both be at the same potential, and it would also be ready connected up for applying the test mentioned above.

In the case of lighting mains, the test wire which is not used for indicating the drop of the potential could be connected to the conductor at both ends; and in the case of a breakdown, the one connected to the voltmeter could be temporarily disconnected and used in conjunction with the other one.

Wm. Dalton.

Newcastle-upon-Tyne,
March 24th, 1902.

A "Poser"!

I should be pleased if you could supply me with an answer to the following question, set at the City and Guilds Examination, 1901:—

A three-phase motor is supplied with currents having a frequency of 50. What speed will it run at, if the inductor has 15 poles, and the slip is 3 per cent.?

P. C.

Overhead Mains.

May I add my testimony to that of Mr. Roberts as to the value of your recent remarks on the above, and say that such experience as I have had, has, like his, tended to confirm all you said.

You, of course, did not advocate the use of bare copper overhead exactly as Mr. Roberts has recommended, and I must say I am unable to see how it could be advisable or economical, even in a Colonial town, to undertake the supply of 250 customers entirely from overhead mains. Mr. Roberts tells us the distances he proposes dealing with are comparatively small, which means that fair numbers of the consumers will often be found close to each other.

It is certainly nice, cheap, and simple to devise and carry out such a scheme to the extent of connecting up a few of the consumers, but it is quite a different thing to live with it and continue to connect a number of customers at such times as they may choose to come on.

It would not be very long before the unfortunate engineer in charge (if I may judge from some little experience of my own) would find that he had taken so many services from one pole that there was really little room for any more. He would then have to think whether he ought to go to the next pole, put up another between, re-arrange all those services he has done, or put additional services underground. If he sticks to the overhead, he has still to decide whether he will run to a consumer's chimney and make his way through some skylight, or such like, or go to the face of the house, if high enough, and get in through the side of a top window, or come down the wall to a lower level, and really there are so many ways of arriving at the same end, each one, if possible, being more objectionable than the other, that the tax of deciding which is the least so, is almost too much for the average individual of only ordinary intelligence.

Add to this the fact that the more consumers he connects up, the more unsightly and unweildly the whole concern becomes; and, to crown all, when he comes to count up the original cost of the scheme, together with what has been spent on the extra lengths of services he has put underground, the high cost of labour and upkeep occasioned by the unreliability and inconvenience of those services he has put overhead, he finds that he could have had underground mains for the same money, if not less.

Let us hope that before he has experienced half this, that the proprietors of the undertaking will have come to his assistance—as others in a similar position have done before—and swept away all the overhead where the consumers are many, or likely to be, leaving only the outlying districts to be so served. In fact, brought the undertaking to the condition in which Mr. Roberts has put Durban; in which instance, if I may say so, he appears to have exercised good judgment. The very same methods were adopted in Bray some nine years ago, and they are giving every satisfaction for lighting country roads.

If I might offer a further opinion, it would be that I believe that nothing will assist more towards the early development of the electrical industry in Ireland, if not the United Kingdom, than free permission to use overhead bare copper conductors, but like all other good things, their use can be carried too far, and they will be done to death again, as they have been before, when we come to put them up for low-tension distributors.

Geo. Marshall Harriss,
Representative in Ireland of Prof. Geo. Forbes.

Carlow, *March 29th*, 1902.

500-volt Shocks and Rail v. Road.

I regret having been unable to reply sooner to your comments on the letter you were good enough to insert in your issue of March 21st.

As regards your comments on the first part of the letter, I am still of opinion that Ohm's law applies in the case of current from a battery.

As regards the relative efficiencies of automobiles and railway trains, your argument, I take it, is that although the draw-bar pull per ton is four times as high for an automobile as for a railway train, the energy consumption per ton is only twice as high, and therefore the automobile is twice as efficient. What I tried to point out is that you have completely ignored the kinetic energy of the train absorbed in braking. On the Central London Railway, of the energy output of the locomotive only one-half is for haulage—that is, for overcoming friction—and the remainder is absorbed in braking. Thus your method of obtaining the efficiency by dividing 28 by 48 is entirely erroneous, 28 watt-hours per ton-mile being the energy consumption for overcoming friction only, as I stated. I suppose the automobile has to stop occasionally, but I find it hard to believe that the most cautious or thirsty "chauffeur" finds it necessary to stop once in every half mile.

In conclusion, you state that the latter part of my letter, "whatever it may mean, is answered by the notes where equal speeds of the two systems are assumed." I can only refer you again to my letter, where you will find that the passage you appear to find so difficult expressly deals with the variation of energy consumption with the distance between stops for a *given speed*. For example, a line with stops 0·5 mile apart will require 10 per cent. more energy per ton-mile than one with stations 0·6 mile apart, other things being equal. I think that I have said sufficient to show the uselessness of comparisons of energy consumption between any two vehicles unless the distances between stops are stated.

William Casson.

Salisbury House, E.C.,
March 30th, 1902.

[We did not question the applicability of Ohm's law to current from a battery.—Eds. Elec. Rev.]

Electricity Supply Tariffs.

Referring to Mr. Baker's article on the "Influence of Tariffs on Electricity Supply," I fail to see any substantial basis for his conclusion that the flat-rate system is the only satisfactory one at present. I have only checked a few of the figures in his tables, but I find that in the cases of the two Newcastle companies and of Cambridge, he has placed them under the wrong headings. His table of the ratio between price obtained and cost does not seem to have much bearing on the matter, and is discounted by the varying local circumstances in each case, of which the system of tariff adopted is only one factor, and I cannot see that it in any way justifies his deduction. It is, in any case, evident that the maximum demand system is as financially successful as the flat-rate system; it is certainly more equitable to the individual consumer, and the average price paid by the consumers in the principal places where it has been adopted is lower than in the case of equally important places charging a flat rate. No general conclusion of any value can be drawn from the figures he has given, and it would be impossible to arrive at one without making an exhaustive analysis of the local controlling circumstances of each case, even if this could be done upon any equitable basis for comparison, the result would scarcely influence the policy of most undertakings.

M. R.

March 3rd, 1902.

Testing and Management of Electric Motors.

Replying to Mr. White's communication in your issue of March 14th, I beg to point out that it was explicitly stated in the original article, that the armature resistance and losses, excepting the loss in the winding, were assumed to be the same at full load as at no load. For a modern shunt-wound motor the discrepancy between this assumption and the facts is commercially negligible. The formula under discussion is derived as follows:—

W = Net output at the motor pulley, expressed in watts.
w = Magnetic and friction losses.
r = Armature and brush resistance, warm.
E = Impressed E.M.F.
C = Armature current required to deliver the power, W.

All of these factors are easily ascertained except C.

The total intake of the armature at full load is

$$E\,C;$$

it is also equal to

$$W + w + C^2 r.$$

Therefore,

$$E\,C = C^2 r + W + w,$$

and

$$E\,C - C^2 r = W + w,$$

which will be recognised as an affected quadratic. Transposing, to get the equation in form for completing the imperfect square:—

$$C^2 r - E\,C = -(W + w)$$

$$C^2 - \frac{E}{r} C = -\frac{W + w}{r}.$$

Completing the square:—

$$C^2 - \frac{E}{r} C + \frac{E^2}{4 r^2} = -\frac{W + w}{r} + \frac{E^2}{4 r^2} = \frac{E^2}{4 r^2} - \frac{W + w}{r}.$$

Taking the square root of each member of the equation:—

$$C - \frac{E}{2 r} = \pm\sqrt{\frac{E^2}{4 r^2} - \frac{W + w}{r}}.$$

In the case under discussion, the negative root of the right-hand member is always the one to be taken. Multiplying the binomial under the vinculum by $(2r)^2$ and dividing its root by $2r$, for convenience, gives

$$\frac{\sqrt{E^2 - 4 r (W + w)}}{2 r};$$

so that

$$C - \frac{E}{2 r} = \frac{-\sqrt{E^2 - 4 r (W + w)}}{2 r},$$

$$\therefore C = \frac{E - \sqrt{E^2 - 4 r (W + w)}}{2 r},$$

I trust that it will now be clear to Mr. White that the numerals "2" and "4" are not constants at all, but coefficients developed in the reduction of the original affected quadratic.

The total input of the motor in watts is

$$E (C + C_f),$$

and the efficiency is obviously

$$\frac{W}{E (C + C_f)},$$

but as this gives a numerical value less than unity and efficiencies are always expressed in percentage, this expression would be multiplied by 100:—

$$\frac{100\,W}{E (C + C_f)} = \text{eff.}$$

It seems scarcely possible that Mr. White's hint No. 7 has been misunderstood in view of his recommendation of a motor "well on top of its load." This is a plain intimation that the efficiency decreases towards full load. I have yet to see a respectable shunt motor that does not increase its efficiency as the load increases up to a point far beyond its full rating.

There is no need to burden your columns with discussion of the effect of weakening a motor field or of raising the brushes while under load. Everyone who has designed or experimented with motors knows that weakening the field will increase the speed until a point is reached where there is not sufficient torque to pull the load, when the speed begins to drop and continues doing so until something goes. Ordinarily the fuses would probably go before the critical point would be reached.

A single trial of raising the brushes of a 10-H.P. or larger motor running under load will dissuade the experimenter from a repetition. Of course the counter E.M.F. cuts down the voltage at the arc, but there usually remains sufficient to produce a destructive flash.

Cecil P. Poole.

New York, *March 24th*, 1902.

Mr. White's last letter is, I think, hardly to the point. Mr. White has implied that the equation

$$C = \frac{E - \sqrt{E^2 - 4 r (W + w)}}{2 r} \qquad (1)$$

contains an empirical constant. I invite him to examine the deduction of the equation from first principles once again and to admit that it contains no such constant.

Both the equations in Mr. White's last letter are incomplete, as they omit to take into account the core, eddy current, windage and friction losses (called w in the original article).

Calling W (as in the original article) the power of the motor, Mr. White says that

$$W = E\,C - C^2 r, \qquad (2)$$

and that equation (1) can be deduced from equation (2). Now as equation (2) contains no term in w, I shall be very interested to learn how Mr. White does it.

Remembering that it is the *commercial* efficiency we are dealing with, and that all losses are assumed to be constant, then

$$W = E\,C - C^2 r - w. \qquad (3)$$

This was given in my letter, and is probably what Mr. White intends to write.

As it always gives tone to the proceedings to drag in the calculus on the smallest provocation, we will find the value of C which makes W a maximum by differentiating equation (3) and equating to zero:—

$$\frac{d\,W}{d\,C} = E - 2\,C\,r. \quad E - 2\,C\,r = 0,$$

or W is a maximum when $C = \frac{E}{2 r}$, which is our old friend the law of maximum activity.

I am still quite unable to see why Mr. White asks what figure 4 represents. It is simply a numerical con-

stant, and any question with regard to it is, to my mind, tantamount to an admission that the inquirer fails to fully grasp the derivation of the equation in which it occurs.

H. W. W. Dix.

Cheddar, *March 29th*, 1902.

500-Volt Shocks.

There seems some doubt among your correspondents as to the genuineness of Mr. Trotter's experience in placing himself across a 500-volt circuit in actual practice—that is to say, on a 500-volt railway where trains were actually running at the time. I can assure your correspondents there is nothing extraordinary or novel about it. Our men working in and about the trains are constantly getting shocks, and I have myself on two or three occasions (accidentally, of course) grasped the conductors and running rail to prevent falling, and have not experienced any serious results. I may say that during the last 12 years' working with 500 volts, I have never known a man injured in any way by shock.

A. Ingram,
Supt. Motor and Carriage Dept., Liverpool Overhead Railway.

INSTITUTION OF ELECTRICAL ENGINEERS (NEWCASTLE SECTION).

ELECTRIC POWER SUPPLY ON THE NORTH-EAST COAST.

By C. S. Vesey Brown, M.I.C.E., Member.

(Paper read March 10th, 1902.)

(Concluded from page 490.)

The next important point to be considered is the pressure at which the trunk mains shall be charged, and here there is, if one may express it as such, a distinct timidity to resort to low pressures, such as 5,000 or 6,000 volts, instead of at least 10,000 or 12,000 volts. The author had some years' experience in the service of the London Electric Supply Corporation's works at the Grosvenor Gallery and at Deptford, and from the latter works 10,000 to 11,000 volts were and are being transmitted daily to the company's London sub-stations. This undertaking was severely handicapped in its early days by the fact that, at each successive stage in the progress of the works and supply, experiments had to be made to determine the limiting range of the insulation required to keep 10,000 volts "in order" in the dynamos, transformers, cables, and switching apparatus, but in spite of the difficulties which were thus presented, and which have been overcome, there can be no hesitation in saying that 10,000 volts is the minimum pressure at which any power station should generate and distribute along its trunk cables. By fixing the standard of 10,000 volts as the pressure at which the current is to be delivered at the distributing end of the trunk cables, there should be no difficulty in transmitting the power over an area with a radius of from 12 to 15 miles from the power station.

The regulations at present issued by the Board of Trade for those works supplying at 10,000 to 11,000 volts contain a clause limiting the power to be transmitted along each trunk main to 1,000 kw. In insisting on this splitting up of the power, the Board of Trade must have overlooked the fact that at the present time gas and water companies are allowed to supply their sub-stations and reservoirs through a single pipe which allows of as much as 4,000 h.p. to 5,000 h.p. being available at the sub-station end of the line, and though the analogy is perhaps not quite the same, yet the insistence on such a clause in the regulations affecting the electric power supply all over the country will add materially to the cost of distributing the power. There should be no objection to a cable carrying 250 amperes at 10,000 volts with a loss of, say, 10 per cent. on the line, and this would allow of, say, 10 or 12 trunk cables from each works.

In planning out a system of trunk cables there should be no difficulty in arranging that intercommunication through suitable cutting-out devices could be made, and failure of supply minimised accordingly. The adoption of any higher pressure than 12,000 volts is surrounded at present by difficulties with the government authorities, and, to a certain extent, there would be required more experience in the behaviour of insulating materials before a pressure of, say, 20,000 volts was fixed as the distribution pressure. In connection with the actual generation at 10,000 or 12,000 volts pressure, the author studied the practice of American and Continental dynamo makers at the Paris Exhibition of 1900, and in no case did the pressure exceed 6,000 volts. On investigating the nature of the insulating materials generally used in the armature windings, it is difficult to reconcile this fact with the pressure of 6,000 volts; it may be that the alarming results which were supposed to have accompanied the use of 10,000 volts on the machines and apparatus at Deptford had exercised their influence on this point, but the writer has no hesitation in saying that what has been done in the past can be done now and in the future. There is to-day running at Deptford an alternator generating at 10,000 volts which was constructed as long ago as 1889, and others have since been installed to supply at the same pressure.

Returning to the subject of the distribution of the power along the trunk cables, and assuming that 10,000 volts is adopted, there should be no difficulty in deciding that the distribution shall be by means of underground cables in order to provide for a continuous supply. An agitation has lately sprung up for the purpose of obtaining permission to distribute by means of overhead wires, after the manner of the American and Continental practice. It may be that the suggestion for overhead wires is for the purpose of supplying at a higher pressure than 10,000 volts, and possibly this will account in some degree for the reason of the agitation; but in view of the difficulties of properly insulating overhead wires at the point of attachment to their supports in all sorts of weather, such as was experienced in this district in November and December of last year, one cannot help supporting the action of those in authority who are loth to depart from the regulations laid down on this point. With your permission the author would refer again to the experience of the Grosvenor Gallery works, which at one time was supplying its consumers at 2,500 volts by means of rubber-insulated overhead wires slung by leather tags from steel suspending wires through various circuits, the total length of which was between 80 and 90 miles of route, and though the lines were well put up and each joint carefully made, there was always a considerable leakage of current. It is true that none of the lines were broken or blown down, and this fact redounds to the credit of the men employed on the work, and to the method employed in suspending the lines; but the poles and wires were many times struck by lightning, and one has only to have the experience (one occasion usually suffices) of seeing the effect of a lightning discharge across the air-gap between the armature and fields of an alternator, to wish overhead wires elsewhere. It will doubtless be said that arresters could be used, but even then the results of interruptions to supply due to momentarily earthing any line charged with 10,000 volts or more may prove a heavier item of expense than the mere loss of revenue due to the interruption of the service. Some mitigation of the difficulties of overhead transmission might be obtained by the use of insulated wires, but it does strike one as resembling the old saying of "taking coal to Newcastle" to put up overhead *insulated* wires. Why not put a little more insulation on and put them underground? In this particular district it is likely that subsidence of the roads due to colliery workings may take place, and for the protection of the "authorised undertaker" it has been suggested that the penalties to which the undertaker is liable, due to interruptions of the supply from this cause, should not be inflicted, and that the words "or by reason of the operation of any colliery" should be added to that section of the Clauses Act which deals with this point.

The question of distribution of the power at the place where it is to be used is one which can be divided into two headings—(*a*) the isolated works, collieries, tramways, &c., and (*b*) the supply to an aggregation of works and for the lighting of separate districts where the population is large enough to warrant a sub-station. In each case probably the first transformation will be by means of the usual form of static transformer to a low-pressure alternating current, and then through a rotary converter to continuous currents as required. In some of the works and collieries referred to as being isolated, it may suffice to supply alternating currents so that three-phase motors may be run direct off the transformers; but where a number of works are supplied from one sub-station, or where house lighting and small power supply is to be considered, it would probably be better to arrange for a continuous current supply distributed on the three-wire system, and, in addition to the usual transforming apparatus, there should be installed a fair sized storage battery for use in case of emergency or repair, &c. From the sub-station to the consumer is a matter which is dealt with in so many ways, and is so well known, that it need not be referred to here in any detail.

A few remarks may be made on the general policy of distributing electrical power from large central stations in view of the opinions which have been expressed against it by many well-known members of the Institution. The two points which directly concern the question are costs and expediency. Is it less costly to generate from, say, one large works with 25,000 h.p. to 30,000 h.p. installed, than from, say, five works, each with 5,000 h.p. to 6,000 h.p.? The author says, "Yes, distinctly so," provided the larger stations are equipped with relatively larger units, but not so if small units of 500 kw. or 1,000 kw. are installed, for then the reduction in costs as the units generated increase disappears when probably 5,000 h.p. or 6,000 h.p. output is reached. The expediency of moving the central generating stations from the densely populated and valuable centres of business to the banks of a river and in proximity to a colliery or collieries is undoubtedly right, and the example set by the gas industry in this direction is one to be followed. The opinion has also been expressed that it is difficult to reconcile the assertion that the cost of generation is less for large central stations than for, say, works in Newcastle, Sunderland, South Shields, &c., because, say the opponents of central power stations, each of these towns is large enough to support a central generating station in itself, and that if a number of towns are grouped on to one large station the cost of cables from the station to each town would be so great as to be prohibitive, and, further, that as the maximum load in each place occurs almost simultaneously there would only result an intensified peak, say, for example, on Saturday evenings. To a certain extent this is true, but as each

place with its separate station has to provide a certain proportion of spare plant, and as each of the works is equipped with comparatively small units of plant, each requiring considerable attention, &c., the aggregation of these numerous small units into fewer large units of plant must tend to economy in attendance and reduction in the percentage of spare plant required, and consequently in capital costs.

Against this it will be said that attention is still required at the sub-stations, but even in this event the larger central station, with its sub-stations, is decidedly less costly than a number of medium-sized works. To take an example of what might have been done in the Tees district, the five towns of Hartlepool, West Hartlepool, Stockton, Middlesbrough, and Thornaby are within a few miles of each other. Three of these towns have works of their own at present, and of the other two one is proposing to erect works, and the other is applying this session for a constructional or managing engineer, or the trader in the electrical apparatus which is so necessary to the power supply authority in extending the business for which the works are established. He wishes to bring before your local committee a suggestion that the power supply authorities mentioned should be approached either by this Institution or any other suggested method to confer on the two points of pressure and periodicity, so that in the laying out of the trunk mains throughout the area there may be interconnection between adjacent stations for the double purpose of securing economy in generation and standardisation of the motors and other electrical apparatus which will be supplied to the users of power throughout the district. The effect of standardising the periodicity and pressure will tend very materially to cheapen the cost of motors and their accessories, which will act beneficially on the power supply authority, with a corresponding reduction in the costs of production and the price per unit to the consumer. The suggestion

TABLE showing the Increase in Gas and Electricity Used and the Increase in Population and Inhabited Houses during the Decade 1891—1901 in all the Areas for which Provisional Orders under Electric Lighting Acts have been granted, and which are within the Areas defined under the different Electric Power Acts or Bills on the North-East Coast.

	Electricity.					Gas.						Population.			Inhabited houses.		
Year.	Prov. orders granted.	Prov. orders put into operation.*	Number of consumers.	Number of units consumed.	Equivalent in 8-c.p. lamps connected.	Gas consumed in the 33 areas, in millions of cubic feet.	Gas consumed in areas where prov. orders are granted, in millions of cubic feet.	Gas consumed in the areas where prov. orders are in operation, in millions of cubic feet.	Gas consumers in 33 areas.	Gas consumers in areas where prov. orders granted.	Gas consumers in areas where prov. orders in operation.	In 33 areas.	In areas where prov. orders granted.	In areas where prov. orders are put into operation.	In 33 areas.	In areas where prov. orders granted.	In areas where orders are in operation.
1891	7	2	341	450,481	23,314	3,731	2,427	997	74,525	52,404	20,000	823,239	530,533	186,300	136,360	76,449	25,423
1896	8	3	940	1,172,538	76,532	4,904	3,418	1,981	94,595	62,330	33,878	—	—	—	—	—	—
1898	9	4	1,413	1,941,431	122,393	5,467	4,095	2,528	111,689	77,473	44,641	—	—	—	—	—	—
1901	33	4	3,026	4,261,731	213,120	5,900	5,900	2,890	120,661	120,661	52,000	1,095,984	1,095,984	458,135	162,191	162,191	61,376
Increase over 1891	...		2,685	3,811,250	189,806	2,169	3,473	1,893	46,136	68,257	32,000	272,745	565,451	261,835	25,831	85,742	36,953

* Eleven more orders were put into operation late in 1900 or during 1901 from which no returns are available at present.

provisional order. Why these Corporations did not combine to put up one central station to supply the three towns now working their own plant, instead of at present running three separate works, it is difficult to say; but there is no doubt that a very considerable economy would have been the result, in at least the buildings and generating plant and the management expenses, and when the two other towns were connected the result would have been a cheaper supply for the ratepayers and power users in each place. Generally speaking, the supply of power to the manufactories, shipyards, collieries, &c., from municipal central stations in the district is small—smaller than the supply by the companies established—and though in some towns, such as, for example, Bradford, Manchester, Liverpool, and Birmingham, &c., a considerable motor load is connected to the mains, there is a tendency to hold back from the supply of electrical power by municipal authorities. Whether this is due to the probable uncertainty of the composition of each year's electrical committee, or on the other hand, the unwillingness of the power user to take any guaranteed consumption, it is difficult to say, but it is for the power supply companies authorised throughout the country and this district to supply the deficiency.

The questions of capital costs for the erection and equipment of the power stations, and prices at which electrical power will be sold to the power users, have been presented to your Institution in many papers at considerable length, so that it is not proposed to enter into any details, but the author considers that there is a field for the employment of at least 10 millions of capital in equipping power stations and their distributing systems in this district, and provided that sufficiently liberal terms are offered to manufacturers and others to use power, sufficient revenue should accrue to return the statutory dividend to the investor.

Throughout this paper nothing has been said, so far, as to the competition of gas supply and its probable effect on large central stations. Where gas is cheap, as it is in some parts of this district, its function will be properly discharged in heating, cooking, and power supply by gas engines, and the annexed table gives some data for the last 10 years which are sufficiently accurate to give encouragement to those engaged in the electrical industry on the North-East Coast that there is a large and ever-increasing demand for light and power. A comparative statement is given showing statistics of the population, inhabited houses, gas and electricity supplied in 1891, 1896, 1898, and 1900 (when the latest reliable returns are available). Incidentally, the investigation required for the above table showed that the housing problem is becoming a serious question in the district, for in 1891 there were 6·1 persons per inhabited house, and at the end of 1900 there were 7·8 persons per house. This is also a fact which will give encouragement to those engaged in this district in traction enterprise.

In concluding this short paper, dealing with a subject which is so interesting to all members of the Institution, and which teems with possibilities almost beyond the "dreams of avarice," the author would welcome a free and open criticism and discussion as to the experiences and ideas of those whose business brings them into contact with any phase of electrical power supply, be it as the which he begs leave to make is that each of the power supply companies, and, if necessary, those who own distribution powers, should appoint a director and an engineer to meet and discuss the two points referred to, and that the conference or commission, as it may be more correctly described, should be empowered to direct all the power companies to adopt a standard pressure of distribution and a standard periodicity for generation.

STORAGE BATTERY TRACTION FAILURES IN GERMANY.

The history of storage battery traction on tramways in Germany is perhaps as unfortunate as that in England, although this particular system has probably been given a more extended trial in the former country than in any other part of the world. One by one the experiments in Great Britain have been discontinued, and the trials made with the Elieson locomotives at Stratford, the battery cars at Barking, the Jarman system at Croydon, and the accumulator cars at Birmingham are matters of the past, and are not likely to be repeated in the future, unless considerable improvements are made in the direction of lightness and greater output of the cells. But whilst these different services have been of a comparatively insignificant character, an exhaustive test of storage battery cars has been made in Germany on a comprehensive scale, and extending over a long period. The most important instance is that of the Hanover Tramway Company, which has not restricted its sphere of activity to the town, but has constructed lines beyond the suburbs to distant localities, and thus changed the nature of the undertaking to that of a secondary railway system. Out of a total length of 165 miles of track 55 miles are situated in Hanover, 14 miles are in Linden, and most of the remaining mileage leads to Hildesheim and Deister. Excepting the municipal area of Hanover, the whole of the external lines are operated on the overhead trolley system, whilst battery cars are employed in the town, because the company had complete confidence in them at the time of the inauguration of the service, and because the municipal authorities might have been equally as indisposed to approve the use of overhead wires at that time as they are at the present moment. The extent of the service will be understood from the fact that 274 battery cars are in constant operation, but the company has for some months past admitted that the introduction of accumulator cars was a serious error, and it is now endeavouring to rectify the mistaken judgment of earlier years. The experience gained from the working of this large number of cars shows that battery traction is too costly, that the heavy weight of the cars wears out the permanent way too quickly, that defects arise which militate against the cars affording an

efficient service, and that the danger of explosions is always present. In these circumstances—which may be interpreted as an indication that storage battery traction in Hanover has proved a commercial failure—the company is desirous of discarding the accumulator cars in favour of the overhead trolley system, but the municipal authorities have hitherto declined to sanction the conversion from the one to the other method. A second instance relates to Hagen, Westphalia, where the local tramway company has a large number of storage battery cars in service, and wishes to substitute the overhead trolley system. In this case also, the local authorities refused to approve the transformation except on conditions which the company found it impossible to accept. The Government commissioner at Arnsberg and the Elberfeld railway administration have, however, intervened in the matter, and have issued an order deciding that in consequence of the inadequacy of the battery car service, the cars are to be removed from the lines by next September, and the overhead trolley system introduced in their place.

The position of affairs at Halle on the Saar affords another striking example of the unsatisfactory results attending the use of accumulator cars. Both the overhead trolley system and battery cars are in operation, the latter having been introduced in order to meet the objections of the University authorities, who considered that the instruments at the Physical Institute would be affected in the event of overhead wires with rail return being permitted within the neighbourhood of the buildings. The tramway company finds that not only are the battery cars unremunerative, but that the losses thereby incurred practically absorb the profits earned by the trolley cars, and that the cars do not afford an efficient service in consequence of frequent breakdowns. In the desire to substitute the overhead trolley system throughout the network, the company has offered to meet the expenditure for the provision, as was the case at Berlin, of protective devices for the instruments at the Physical Institute, and to defray the expenses of regulation and repair of the instruments. This proposal having been declined by the University authorities, the company now intends to invoke the aid of the law in order to endeavour to proceed with the work of conversion. The remainder of the battery cars at Berlin, where the service has been equally unsatisfactory and the cars have caused many accidents, are to be removed in consequence of an order issued by the police authorities, and are to be replaced by the overhead system. It is, therefore, highly probable that in consequence of the disastrous financial returns which have resulted from these four cases of the operation of battery cars on a large scale, none of the tramway companies which still employ horse traction will be disposed to consider the question of introducing battery cars in the future. The system has proved to be entirely unsuitable for dealing with passenger traffic on a satisfactory basis; and on almost all occasions when the question of improved locomotion is discussed, the only method which meets with favour is the overhead trolley system.

SUBMARINE MINES.

Perhaps the most important use that electricity is put to in the Navy is in mining operations for exploding charges against an enemy from a distance.

This class of armament may be roughly divided into two heads, viz., offensive and defensive weapons, of which the defensive may be said to be the most reliable.

Under the head of defensive weapons we should class mechanical, electro-contact and observation mines, and the latter as the most important of all, for they lie absolutely safe and inert under the bottoms of all friendly ships, but become a most effective barrier to the enemy.

Under the head of offensive weapons we should class electro-contact and mechanical mines, outrigger torpedoes, creeps, sweeps, counter mines and explosive charges.

It is interesting to look back upon the history of torpedo warfare for a brief space.

War carried on with the direct action of explosions was practically introduced by Bushnell, an American, and we see it rapidly developing throughout the American war.

Bushnell after attempting to fix explosive charges beneath ships by means of a submarine boat, at length turned his attention solely to torpedoes, and in 1777 we find him attempting to blow up the *Cumberland* by means of a couple of floating torpedoes joined together with a line, and set to drift so that when the line caught against her cable the two mines coming one on either side of her, and having mechanism worked by revolving wheels in the tideway, would eventually explode. This attack failed in its object, but blew up a schooner anchored near.

After this Fulton blew up a small vessel, the *Dorothea*, off Deal, in the presence of Pitt. These methods were denounced as unbecoming the British nation at the time, and returning to America, he wrote a pamphlet about torpedoes.

Public opinion was much against Fulton, but in 1810 the United States appointed a commission, consisting of Commodore Rodgers and Captain Chauncey, of the U.S. Navy, to investigate his designs. His torpedo consisted of a copper case containing 100 lbs. of powder, fired by two levers and a gunlock, and it was proposed to fire a harpoon, attached to a buoy, at the ship, the torpedo being about 10 ft. below the surface, supported by the buoy. The two captains differed in their reports, and Rodgers ridiculed the whole thing; but being told to defend himself against Fulton's attack, he hung weights at his yard arms, rigged large swinging booms with scythes on them, and generally constructed such a defence as rendered his ship totally unfit for any other service. He kept Fulton at a distance, but proved his (Fulton's) success by rendering the ship unfit for action.

In 1812 an attempt on H.M.S. *Plantagenet*, lying in an American port, was condemned by the English as "cowardly, villainous, and improper."

But in spite of public opinion, the torpedo was working its way into prominence, and was soon recognised as a legitimate method of conducting warfare.

It was during the American war that the torpedo gained a footing. An attempt to destroy the *Memphis*, and later the *Minnesota* and *Wabash*, convinced the Northerners that it was useless to allow an enemy to pursue such methods without replying in the same manner.

Lieut. Cushing attacked the *Albemarle* eight miles up the Roanoake river, and sunk her with an outrigger torpedo, very much like our own in present use.

Colt was, perhaps, the first to demonstrate what could be done with electricity in this line; he blew up a brig of 1400 tons, moving at the rate of 4 knots, with electricity from a station 5 miles distant; he kept his plans secret, but it is believed that he used a camera obscura, and fired his mine by pressing a key.

We now find the Confederates making what were known as frame torpedoes, which were composed of several spars, pointed and buoyant at one end, and bolted to a long horizontal spar at the other end; this spar was moored to the bottom, so that the torpedo spars floated vertically in rows. The torpedo was somewhat curious; it consisted of a sort of shell, containing 27 lbs. of powder, and weakened considerably in the middle; it was fired electrically, and the head broke off, and formed a projectile to pierce an enemy's bottom. These frame torpedoes exercised such a vast moral effect, that ships were very much hampered by them.

In the James River we find the *Commodore Jones* blown to pieces with 2,000 lbs. of powder fired electrically, and the *Tecumseh* sinking in Mobile Bay in one minute.

In the Russian war the Russians made use of mines which exploded upon being bumped, and two gunboats, the *Merlin* and *Firefly*, received a severe shaking through striking such mines, many of which were afterwards raised and got rid of by the English.

In the Russo-Turkish war, and the French and Chinese, we also hear of torpedoes, and we may notice the case of an Austrian cruiser which, when chased, eluded her pursuers by taking a zig-zag course over an imaginary mine field, where the enemy were afraid of following her.

Thus we see that the moral effect of mines, especially electric mines, is a considerable item in modern warfare.

The mines adopted by almost all nations now may be divided into two classes, self-acting or electro-mechanical, and observation mines.

Perhaps the latter, being the most important, will be the best to take first. They are laid down in rows, intended chiefly to guard narrow entrances, and consist of large cases of gun-cotton or dynamite, in which are inserted electric fuses; each mine is connected by a branch to the main cable, which runs along the whole line and comes ashore to the observing station, where the batteries are placed. The fuses are generally two or more in number, and are joined up in fork, so that should there be a rupture in the fusible bridge of one the circuit will not be interfered with as regards the second or third, and the mine will still fire.

The circuit is made by an observer, who, on sighting an enemy about to enter, switches in the batteries and follows the ship with a telescope mounted upon a graduated arm, called a range finder. This instrument completes the circuit when the telescope points directly over the line of mines, and thus either the whole line or any particular mine may be fired as the ship passes over the spot.

The mines are laid down at such a distance apart that the destructive radius of one touches or overlaps the destructive radius of its neighbour. Sometimes the minefield is laid down in a kind of chequer work, so that the destructive radius of one mine will overlap those of four others adjacent to it, and thus ensure the destruction of a ship passing between two of the first row of mines.

The mines are either buoyant and moored at a certain depth below the water-line or they rest on the bottom. The French employ a mushroom-shaped mine, which rests upon the bottom, and is moored by its own weight, but, though very unobtrusive, these mines can only be laid in certain harbours where the depth is not great, so that the explosion shall take place in close proximity to the ship's bottom.

The majority of mines, however, are either buoyant and rest a few feet below the surface or can be made to rise by an electric release when required; some of these can even be raised and sunk at will, from the observing station, but as all such devices require constant attention, they are compassed with many disadvantages. For naval purposes, the buoyant mines are far the most practicable, and can be laid down very expeditiously from a large boat.

When mines are intended to be fired singly, means must, of course, be provided to cut out the ruptured branch from the main cable, and this is effected by watertight fusible cut-outs which fuse with the bridges that explode the mine; they take, however, a larger current to fuse them, and consequently the branch is not cut out until the mine itself has fired.

The practice of firing single mines is condemned by many of the highest authorities, who maintain that in all cases a whole line should be fired in order to ensure the ship being within a destructive radius.

We now come to the mechanical mines which are self-acting; they may be joined up to batteries on shore which, when switched on, will fire the mine directly a passing ship bumps it, and thereby

makes contact within the mine itself, or each mine may contain its own firing battery, but in the latter case it will be seen that the mine being entirely self-acting, is just as dangerous to friends as to foes.

There are many devices for firing a mine automatically upon its being bumped, but in no case has the difficulty of distinguishing between friends and foes been got over unless the batteries are placed ashore where they can be switched out of the circuit.

These self-acting mines are not all electric. The Russians use a mixture of chlorate of potash and sugar in which a glass tube containing sulphuric acid is buried, the whole being contained in a brass tube which projects from the mine; a ship striking this tube would bend it, break the tube and liberate the acid among the mixture, resulting in its combustion and the explosion of the mine.

Very naturally the details in connection with mines are jealously-guarded secrets, but certain devices are common property to all nations, and perhaps one of the most ingenious of these, and at the same time a very simple one, is the "unstable cell." This consists of a case containing the explosive with an electric fuse which can be fired by a battery resting on a shelf. The battery is of such a shape that it can be very easily upset, in which position the liquid flows over the two electrodes and renders the cell active, with the result that the fuse is fired.

Such a mine is essentially a weapon of offence; it would be used to blockade an enemy's harbour in order to prevent his fleet going to sea.

The chief defence against mines is carried out with counter-mines, and these would be run over the ground before making an advance through a suspected channel.

Counter-mines are laid down by boats at full speed, being dropped in straight lines, or rather in one continuous straight line; directly all are laid, they are fired, and by this means all mines within a certain distance of the line are destroyed, and a safe channel secured.

Counter-mines would probably be laid down at night and the boats would be subjected to a heavy fire from the enemy's guns, so that various designs have been proposed by which a steam launch, with no one inside her, shall be electrically steered from the ship following, and drop the mines automatically.

Other methods of putting an enemy's mines out of action are sometimes employed when the mines are known to be electric. A special form of grapnel is towed along the bottom until it catches in what is presumed to be an enemy's cable, it has a small charge of gun-cotton attached to it, and this being fired destroys the cable; this is known as "creeping" for cables.

Weighted ropes or chains towed so as to hang between two boats pulling abreast are also used to catch vertical cables or the moorings of buoyant mines: this is known as "sweeping," and was employed with much success in the American war.

The great object of all mining operations, as distinguished from torpedoes, is to produce a moral effect that shall keep an enemy from entering one's harbours; to produce such an effect their efficiency must be fully demonstrated by experiments in times of peace, and just as the introduction of gyroscope torpedoes with a range of a mile places an action at least at that distance, so the existence of efficient mines in our home ports is likely to keep hostile fleets from our harbours. The electrical mine and the torpedo are probably not such terrible weapons as they appear at first sight, for by their influence in modern warfare the disablement of a ship will most likely be carried out at long range where the loss of life would not be on such a big scale as would be inevitable at close quarters.

BUSINESS NOTES.

Books Received.—"Magnetismo e Elettricità," by F. Grassi. Milan: U. Hoepli. 1902. L5.50.

"Die Schutzvorrichtungen der Starkstromtechnik gegen Atmosphärische Entladungen," by Dr. G. Benischke. "Parallelbetrieb von Wechselstrommaschinen," by Dr. G. Benischke. Brunswick: F. Vieweg & Son. 1902. M. 1.20 each.

"Les Cables Sous-Marins," by Alfred Gay. Paris: Gauthier-Villars. 2 fr. 50 c.

"Cryoscopie," by F. M. Raoult; "Franges d'Interférence," by J. Macé de Lépinay; "La Géometrie non Euclidienne," by P. Barbarin; "Geometrographie," by E. Lemoine; "Théorie de la Lune," by H. Andoyer; "Le Phénomène de Kerr," by E. Néculcéa. Paris: C. Naud. 2 fr. each, or 10 fr. for the half-dozen.

Science Abstracts, No. 51, March 25th. London: The Feilden Publishing Company, Limited. 2s.

Under "Books Received," we recently gave *Science Abstracts* as being published by Messrs. E. & F. N. Spon, Limited. It is necessary to correct this, however, the publication having been issued by the Feilden Publishing Company, Limited, from Temple Chambers, Embankment, E.C., since January of this year.

Robertson Lamps.—The General Electric Company inform us that quite a number of deputations from scientific institutions have lately visited the Brook Green Works, Hammersmith, where the Robertson lamps are made, viz., on the 13th ult., a party of students from the Institution of Electrical Engineers; on the 19th ult., the students of the Institution of Civil Engineers; and on the 20th the Electrical Class from University College.

Electrical Wares Exported.

Week ending Mar. 26th, 1901.

		Value £
Adelaide		62
,,	Teleg. cable	68
Alexandria		87
Amsterdam		60
Bombay		84
Boston		145
Buenos Ayres.		206
,,	Teleg. cable	120
,,	Teleg. mat.	249
,,	Creosoted teleg. poles	340
Calcutta		555
,,	Teleg. cable	195
Cape Town		1,288
Coatzacoalcos.	Teleg. appts.	135
Colombo		104
Copenhagen.	Teleg. wire	51
Durban		697
East London		15
Fremantle		86
,,	Teleg. mat.	234
,,	Teleph. cable	1,172
Grenada.	Teleg. apparatus	41
Hobart		1,851
Hong Kong		1,000
Huelva		680
Madras		135
Malta		10
Melbourne		381
North Atlantic.	Teleg. cale	2,600
Ostend		204
Penang		115
Pernambuco.	Teleg. cable	15,500
Perth		76
Port Elizabeth		13
Port Said		26
Rio Janeiro		17
Rotterdam.	Teleg. mat.	43
Santiago de Chili.	Telephones	28
Sydney		1,739
,,	Teleg. cable	149
Trinidad		4
Wellington		8
Zanzibar		143
Total		**£30,666**

Week ending Mar. 25th, 1902.

		Value £
Adelaide		400
Aden.	Teleg. mat.	964
Alexandria		42
Amsterdam		115
Bombay		76
Bremen		80
Calcutta		1,180
,,	Teleg. wire	512
Callao.	Teleg. buoys	34
Cape Town		937
Cartagena		65
Channel Islands		91
Christchurch		42
Copenhagen.	Teleg. wire	18
Durban		1,560
East London		1,028
Fremantle		13
Gibraltar		46
Hobart		15
Karachi		100
Liban		60
Lisbon.	Teleg. cable	900
Madras		230
North Atlantic.	Teleg. cable	1,840
Port Elizabeth		196
Rio de Janeiro		24
St. Petersburg.	Teleg. cable	135
Shanghai		604
Sydney		347
Syra.	Teleg. mat.	90
Valparaiso		230
Wellington		1,994
Total		**£18,988**

Foreign Goods Transhipped.

		Value £
Bangkok.	Electl. machny.	310
Total		**£310**

		Value £
Calcutta.	Elec. appts.	29
Durban.	Elec. goods	48
Hong Kong.	Elec. mat.	12
New York.	Elec. goods.	80
Total		**£169**

Electrical Wares Exported.

Week ending April 2nd, 1901.

		Value £
Adelaide		593
,,	Teleg. wire	743
Alexandria.		107
,,	Telephones	54
Amsterdam		35
Auckland		91
Bilbao		30
Brisbane		425
Buenos Ayres		57
,,	Teleg. mat.	291
,,	Teleph. cable	386
Calais		58
Calcutta		533
,,	Teleg. wire	86
Cape Town		42
,,	Teleg. mat.	1,198
Chinde		42
Christiania		59
,,	Teleg. wire	51
Colombo		67
Durban		795
East London		536
Fremantle		21
Hamburg		147
Hobart.	Telephone cable	268
Kobe.	Teleg. cable	6,584
Kure		83
,,	Teleg. cable	2,471
Leghorn		17
Madras		8
Malta		38
Melbourne		200
,,	Teleg. cable	1,488
Paris		65
Perth		153
Port Elizabeth		1,454
Rio Janeiro.	Teleg. mat.	68
St. Helena		15
St. Petersburg.	Teleg. mat.	300
Shanghai		105
Singapore		92
Stockholm.	Teleg. wire	691
Sydney		3,081
,,	Teleg. wire	1,654
Valparaiso.	Teleg. mat.	61
Wellington		820
,,	Telephones	2,770
Total		**£28,848**

Week ending April 1st, 1902.

		Value £
Adelaide		175
Amsterdam		38
Bangkok		201
Bombay		445
,,	Teleg. wire	81
Buenos Ayres		181
Calcutta		410
Cape Town		214
Chinde		81
Colombo		46
Durban		1,345
Fremantle		208
Gibraltar		10
Hamburg		90
Hong Kong		82
Madras		90
Melbourne		280
Nagasaki		80
Odessa		70
Port Elizabeth		81
Santos		491
Shanghai		300
Sydney		514
,,	Teleg. mat.	60
Wellington		195
,,	Elec. tubes	22
Yokohama		2,424
Total		**£8,314**

Foreign Goods Transhipped.

		Value £
Cape Town.	Elec. light appar.	20
St. Michaels.	Elec. machinery	1,500
Sydney.	Elec. lighting appar.	80
Total		**£1,580**

Bankruptcy Proceedings.—Notice of a supplementary dividend of 4¾d. in the £ is given in the *London Gazette* in the case of Geo. Benjamin Wright, of Wolverhampton, who is described as "consulting engineer and commission agent, formerly iron-founder and ironmaster, and subsequently electrical engineer."

The *London Gazette* notifies that the debts having been paid, the adjudication was annulled, and the receiving order rescinded on March 24th in the case of C. A. Church (Hy. Conolly & Co.), manufacturing electrical engineer, of Hampstead, and other addresses.

Dissolutions and Liquidations.—The Doe Portable Electric Light and Power Syndicate is winding-up voluntarily, with Mr. G. H. Tyler, of Birmingham, as liquidator. Creditors should send usual particulars to Mr. Tyler by May 10th.

A meeting of the Eclipse Brass and Copper Company will be held at York on April 29th, to hear an account of the winding-up from the liquidators.

A meeting of the General Engineering Company, Limited, is to be held at 2, Penywern Road, S.W., on May 5th, to hear an account of the winding-up.

Messrs. M. Lawton, W. J. Charles, and A. Watson (Alfred Watson & Co., electrical engineers and electrical accessories manufacturers) have dissolved partnership. Debts will be attended to by Messrs. Charles & Watson, who will continue the business under the old style.

The Astbury Electrician's Lathe. — Mr. W. H. Astbury, machine tool engineer, of Nottingham, has designed a 4-in. lathe for producing light work required by electricians, for jobbing work purposes in electric stations, and so on. The tool is claimed to be at once new and compact in its general arrangements. It is also claimed that the form and weight of the column on which the bed is mounted ensure absolute steadiness, besides affording a convenient container for tools and accessories. We are informed that, owing to the peculiarity of the design, stiffer jobs can be dealt with than is usual on a 4-in. lathe, whilst due regard has been given to convenience in manipulation. A priced circular of this lathe can be obtained on application to Mr. Astbury.

Catalogues.—The International Electrical Engineering Company, of Clun House, W.C., have sent us a copy of their No. 5 Bulletin, describing the electrical power installation which the Liége works of the firm carried out at the Ougree Blast Furnaces and Steel Works. The electrical power installation is of special interest, in that the dynamos are direct coupled to single-cylinder blast furnace gas engines of 600 H.P. each. We are informed that they are found to run perfectly in parallel. Besides the motor equipments for the hoists, conveyors, live rolls, &c., the installation includes 10 overhead travelling cranes, some with four motors, and also electric locomotives for moving the 20-ton steel ladles. The same company has also issued a No. 4 Bulletin, giving particulars of continuous current dynamos, motors, switchboards, starting switches, &c. All the coils of the machines are wound on formers, so as to be strictly interchangeable, and they are taped by special machinery. We understand that the firm manufactures all its own micanite and other insulation. Dimensions are given of standard sizes of machines ranging from ½ to 475 H.P.

The Bedford Engineering Company have sent us a well-illustrated list of their steam cranes (locomotive, fixed, portable, &c.), also overhead electric travellers.

Messrs. D. Anderson & Son, Limited, manufacturers of roofing felts, of Belfast, have sent us a perpetual wall calendar.

E.E. (R.E.) Volunteer Settlers at the Front.—It will interest our readers to learn that there has just been formed the Transvaal Engineering Company, of Johannesburg and Pretoria, electrical and general engineers. The partners of this company are two of the late E.E. (R.E.) V. first contingent members, and now settlers in South Africa, Messrs. Silverthorne and T. H. Brown by name. They have just secured the contract for the installation of electric light in the new Government offices, situated in Pretorius Street, Pretoria. The installation consists of 280 lights, 16-c.p. each. They have also many orders pending completion for plant and machinery for the Transvaal Cold Storage Company, the Pretoria Lighting Company, and private contracts for complete electric light installations.

Fire.—On 28th ult. a fire occurred on the premises of Messrs. Marshall & Woods, electric light engineers, of 2, Gray's Inn Road.

"Flying."—We have received the second number (March) of a new quarterly magazine published by Messrs. Iliffe & Sons, Limited, St. Bride Street, at 2s. 6d. It purports to be a record of aerial navigation, incorporating "the flyer, the flying machine, the aerostat, and the aeronaut," and it appears to us to be a most interesting publication, full of practical matter, which is very liberally illustrated by neat sketches and photographs. Scientific men who are interesting themselves in aeronautics will welcome *Flying*, if we mistake not.

For Sale.—Particulars are given in our advertisements to-day of certain freehold property at Manchester, suitable for electrical or other engineering works, now being offered for sale by private treaty, Messrs. Wheatley Kirk being the auctioneers.

Nelson Electricity Works.—In our article on this subject last week, no mention was made of the fact that the whole of the boilers, steam pipes, &c., in the works were covered with non-conducting composition by Messrs. F. Leroy & Co., of Lower Broughton, Manchester.

Reduction of Capital. — A petition presented on March 25th for confirming a special resolution reducing the capital of the Chloride Electrical Storage Syndicate from £262,500 to £135,250 is to be heard at the Assize Courts, Strangeways, Manchester, on Monday, April 14th.

Trade Announcements.—Messrs. Monté Callow & Co. have removed to larger and more convenient premises at 6, Ludgate Broadway, E.C., where they will hold a stock of "Perfecta" resistance apparatus to meet ordinary requirements. We have received a very handy portfolio of their price lists of motor starters, reversers, regulators, and controllers for direct and polyphase currents; also field regulators. The lists are very neatly arranged and illustrated. The firm are also agents for the London district for Atkinson's ammeters and voltmeters, a pamphlet relating to which is before us.

The Direct Spanish Telegraph Company, Limited, are removing their general offices from 280, Winchester House, E.C., to 66, Electra House, Moorgate, E.C., on 7th inst.

Owing to the increase of business in Sheffield and District, the Electrical Company, Limited, have found it necessary to open a branch in Sheffield. Mr. K. R. Stuart, who has been with the company for many years, has been appointed manager. The address of this branch is 17, York Street, Sheffield.

ELECTRIC LIGHT AND POWER NOTES.

Auckland (N.Z.).—It is reported from New Zealand that Captain W. B. Brain, of Auckland, has invented an accumulator of remarkably high capacity, but no particulars of its construction are to hand. We learn also that the Captain has bought a waterfall 20 miles from Auckland, and proposes to transmit energy by cable 7 or 8 miles to a battery-charging station, and to send the charged accumulators to Auckland in punts. We wish him joy of his job.

Bolton.—Mr. A. A. Day, the electrical engineer, suggests that the following prices for the supply of motive power be adopted from April 1st:—Motors under 4 H.P., and intermittent users of larger motors, price 1½d. per unit, less 10 per cent.; motors used continually, 4 H.P. and over, 1¼d., less 10 per cent. Customers using not less than 25 H.P. for 48 hours per week, 1¼d., less 20 per cent., or 1d. per unit net. Tramways, 1¼d. net.

Bridlington.—The T.C. has resolved to employ a consulting electrical engineer to prepare plans, specifications, and estimates for an electricity works.

Briton Ferry.—The U.D.C. has decided to make application to the L.G.B. for sanction to borrow £4,000 for electric lighting.

Cauvery Falls.—According to the *Rangoon Times*, three Brahmin graduates, and a young European assistant engineer named Rice, have been selected by the Mysore Government to proceed to New York for the purpose of three years' training as electrical engineers, in view of the future requirements of the Cauvery Electric Power Works. During their training they will be paid a monthly salary, not only by the Government, but by an electrical engineering firm in New York who have undertaken to educate them, and, on qualifying, they will be provided with superior appointments at the Falls.

Devonport.—The arbitration case in connection with the Corporation electricity supply was commenced at the offices of Messrs. Preece & Cardew last week. The proceedings were private.

Dorking.—An agreement between the U.D.C. and Edmundson's Electricity Corporation has been drafted.

Dover.—The T.C. has resolved to seal the agreement for the purchase of the electricity supply undertaking for £142,000.

Exeter.—A L.G.B. inquiry was held on 21st ult. by Col. A. G. Durnford, R.E., into an application of the City Council for leave to borrow £70,000 for electric lighting purposes. The capacity of the electricity works, which were bought by the Corporation from a company in 1896, is 410 KW., with 26,628 lamps connected. The Council proposes to build a new station on a favourable site, of 1,300 KW. capacity, and capable of extension, at a cost of £70,000. The items estimated are as follows:—Site (2 acres), £1,820; buildings, £15,296; railway siding, £600; boilers, £1,264; generating plant (Westinghouse), £29,707; feeders, £3,500; extensions of mains, £9,030; sub-stations, switchboards, &c., £1,000; alterations to motors, £500; transformers, £1,138; meters, £1,805; mechanical accessories, £14,622; contingencies, £2,000. An alternative scheme was put forward by Mr. T. W. Letheren, electrical engineer, of Exeter, who pointed out the necessity of providing for electric traction, and the superiority of direct current supply.

Hamilton.—The T.C. has agreed to an arrangement with Messrs. Edmundson's Electricity Corporation, Limited, to supply electricity to the burgh. It is open to the Corporation to purchase the installation and plant at the end of five or ten years.

Hendon.—There is considerable local opposition to the U.D.C's. electric lighting scheme, by which it is proposed to spend £56,000. Meanwhile the Council's prov. order has been extended till May, 1903.

Manchester.—The L.G.B. has sanctioned the application of the Corporation to borrow £477,000 for purposes connected with the electricity undertaking.

Melrose.—The District Lunacy Board has resolved to introduce the electric light into the asylum, erecting its own generating plant.

Salford.—The special committee appointed to conduct an inquiry into the electricity department of the Corporation met last week. The following terms of reference from the Council were brought before the committee:—

1. As to the building, &c., of the Walness Works.
2. As to whether the aforesaid works could have been enlarged (so as to use the machinery at present contained therein) sufficiently to supply electric current for the necessary lighting, and to run the tramways at the present time, and for the next five years.
3. As to the total power provided in the Walness Works and the new works, and if found to be in excess of the requirements for the next five years, to go thoroughly into the matter, and report to the Council as to who is responsible.
4. As to any other matters that in their judgment should be inquired into, and report thereon, and they be empowered to go to any expense necessary to carry out this inquiry.

The committee decided to recommend the Council to appoint some legal gentleman to conduct the inquiry. It was also decided that all evidence adduced must be given on oath.

The E.L. Committee proposes that from October 1st the charges for electricity shall be reduced as follows:—For lighting, 4d. per unit, with a minimum payment of 13s. 4d. per quarter; for power, 1½d. for over 5,000 units per quarter, and for a less quantity 2d. for the first 2,500 units, and 1½d. for the remainder.

Shipley.—The School Board has appointed Mr. R. C. Quin consulting electrical engineer to supervise the carrying-out of an installation of the electric light in the Central Schools.

Spain.—A central electric lighting station has recently been completed and put in operation in the town of Quintanar de la Sierra (Burgos province). Water-power is utilised.

Stourbridge.—The U.D.C. is negotiating with the B.E.T. Company with a view to the transfer of the Council's prov. order to the company.

Surbiton.—The Board of Trade has approved the agreement between the U.D.C. and Messrs. Callender's Cable and Construction Company, and the L.G.B. has sanctioned the necessary loan for the electric lighting scheme.

Worcester.—The Electricity Committee has decided to supply energy for Coronation illumination purposes at a charge of 1d. for ten lamps for three hours.

ELECTRIC TRACTION NOTES.

Ayr.—The Corporation electric tramways have now been running for six months. The receipts work out at about 7¼d. per car-mile; the total receipts amount to £3,554. The cost of the energy used is reported to be £617.

Birkdale.—The first electric car for public service ran on March 27th. The Board of Trade have laid down that the maximum speed to be attained by the cars in Aughton and York Roads shall be 10 miles an hour; Weld Road, 6; and Lulworth Road, 4. The Birkdale District Electric Supply Company are under penalty to provide current by June 30th, by which time it is probable the greater portion of the system will be in full working order.

Bradford.—Bradford has adopted the way-bill system for checking the conductors' receipts, has applied the *queue* system to several routes with satisfactory results, and is trying on the tops of cars spring seats which double up perpendicularly when the passenger rises, and thus catch the minimum of rain. On Easter Monday the traffic receipts were estimated to reach £1,060.

Burnley.—The new electric tramways which the Corporation have constructed from Nelson through Burnley to Padiham were formally opened on March 26th. The line is 7½ miles long, and the cost is about £100,000, apart from the £53,000 paid for the old steam tramway.

Darlington.—The Tramways Committee met last week, and considered the report of Messrs. Kennedy & Jenkin as to the form of electric tramways to be adopted, and the relative cost of the overhead and conduit systems. It was unanimously decided to recommend the adoption of the overhead system throughout the length of about 5 miles. The estimated cost of the lines, without including the purchase price of the old tramways (£7,500), was stated at about £90,000.

Durban.—In the *Natal Government Gazette* is published notice of application for a Bill in the Legislative Assembly to empower Sir Benjamin Wesley Greenacre, K.B., and other (specified) persons to construct a tramway to be worked by electricity in certain streets of Durban.

East Ham.—The E.L. Committee has been asked by the West Ham town clerk whether the East Ham Council would be willing to work the whole of the lines until their plant is completed. The West Ham Council proposes to proceed at once with the construction of its lines.

Glasgow.—The entirely new route of tramways between Glasgow and the neighbouring burgh of Rutherglen was to be officially opened this week. The fares of the whole system are being readjusted, and there is every probability of extending the ½d. fare for a distance not exceeding two-thirds of a mile, and the 1d. fare for a distance not exceeding two and one-third miles on the average. These, however, are not yet officially sanctioned. There being considerable surplus power at the Pinkston generating station, it is under consideration for the tramways department to supply current to the lighting department.

Halifax.—As the result of a long inquiry by a sub-committee appointed to go thoroughly into the subject, the Electricity Committee of the Corporation has decided "that the charge for the supply of electricity for tramway purposes be 2d. per unit."

Isle of Man.—Mr. W. H. Walker, liquidator and receiver of the Isle of Man Tramways and Electric Power Company, Limited, is to receive about £7,600 as remuneration for services in connection with the liquidation of the company named. The whole undertaking of the company realised about £304,000, on which the Clerk of the Rolls in the Chancery Division of the High Court, Douglas, on Wednesday of last week allowed 2½ per cent. as the liquidator's remuneration. Mr. Walker was appointed receiver and manager of the company on June 21st, 1900, liquidator on July 11th, and receiver to the debenture holders on July 25th, 1900.

Loughborough.—At a meeting of the General Purposes Committee of the Loughborough Town Council last week, it was resolved that the time given to the Loughborough and District Light Railway Syndicate, Limited, to decide whether they will accept the transfer of the electrical powers of the Corporation on terms to be settled, and subject to their carrying out concurrently their powers under the Light Railway Order, be extended to April 30th next.

London United.—The following figures show the traffic on these tramways during the Easter holidays:—

	1901.	1902.	Increase.
Good Friday ..	119,565	143,782	24,217
Easter Monday ..	164,390	261,418	97,028
Passengers ..	283,955	405,200	121,245

	August Bank Holiday. 1901.	Easter Monday. 1902.	Increase on previous record.
Passengers ..	218,000	261,418	43,418

Mersey Railway.—At last week's meeting of this railway company in London, the Chairman said that with regard to the accounts, there was only one matter to which it was necessary to refer—the effect of the opening of the Birkenhead electrical tramways. The result had been to take away a certain amount of traffic that had hitherto travelled by the tunnel. This was one of the strong reasons which showed that it was essential for the company to abandon steam and take to electric traction on their undertaking. The loss of traffic could not be obviated until the company were able to give the public a better means of getting across the river. He entertained little doubt as to what would happen when they had the best means of crossing the river.

Middleton.—The tramways of the B.E.T. Co. are now in full working order in this district. On the 8¾ miles of track 20 cars will be run, 10 of which have been supplied by the Brush Company, of Loughborough, and 10 by Messrs. Dick, Kerr and Co., of Preston. The latter firm have supplied all the trucks of the maximum traction type and the whole of their equipments. The Tidswell life guards with additional side guards are being used. The number of men it will be necessary to employ when all the cars are running is 80.

Moville.—Application is to be made to the Irish Privy Council for a provisional order authorising the construction of an electric tramway from Derry to Moville. The route extends over some 18 miles, and engineers are engaged in survey and on the plans. It is proposed to generate electricity by turbines driven by water power. Moville is an important calling place for American and Canadian liners, and it has no railway connection with Derry.

Mytholmroyd.—The Mytholmroyd District Council has addressed complaints to the Halifax Corporation of false fire alarms being given by the contact of tramway wires with fire alarm wires. It asks for payment of costs arising out of such false alarms.

Oldham.—Plans and estimates for a new car shed in Neville Street, off Middleton Road, have been passed by the Tramways Committee. It is estimated to hold about 70 cars. Wallshaw Street car depôt, which is to hold 70 cars, is nearing completion. The questions of commencing a parcel service on the trams and the issuing of contract tickets have also been discussed by the Committee, but left over for further information and consideration. The general manager of the tramways views with disfavour the issuing of contract tickets, and states that there is only about one other town using such tickets on its tramways.

Russia.—The question of converting the horse and steam tramways in the city of Odessa into electric lines is at present under consideration.

Sandwich.—A Joint Committee has reported that it is desirable that the suggested light railway from Sandwich Quay by way of the Sandhills to the North End of Deal should be recommended to the two Councils for adoption, and the respective Councils be asked to authorise the Committee to engage the services

of an expert at a cost not exceeding 50 guineas, to report upon the whole subject, this initial expense to be borne by the respective Councils in equal shares. The Sandwich T.C. has agreed to this.

Sheffield.—A tramcar accident occurred on March 27th. A car containing 34 passengers was standing at the intake terminus, which is at the top of a long and severe hill. The driver was for the moment absent, and the conductor, being unaware of this, released the brake at the back of the car and allowed it to start. It ran down the hill 300 yds., and, acquiring great speed, finally left the metals and dashed into the palisading surrounding a monumental mason's yard. Luckily no one was seriously injured.

Swindon.—The T.C. intends to apply for sanction to borrow £36,000 for electric tramways.

West Middlesex.—A conference of representatives of local authorities, held on 26th ult. at the Westminster Palace Hotel, attended by delegates from Heston, Isleworth, Twickenham, Ealing, Acton, Teddington, &c., approved of resolutions (*a*) to oppose the Middlesex County Council's Bill; (*b*) to recommend retention of leading counsel; (*c*) to form a committee; (*d*) to call the attention of the L.G.B. and Board of Trade to the fact that the Bill proposes an important alteration of the general law.

Wolverhampton. — Mr. Henry Lea, M.I.C.E., of Bennett's Hill, Birmingham, the expert appointed by the Corporation to watch the working of the Lorain system of electric traction, as demonstrated on the experimental mile, has lately presented his report to the Tramways Committee. It is accompanied by diagrams showing sectional views of the track itself. Mr. Lea describes minutely every section of the system, the boxes, their purpose, and the manner in which they are disposed along the track; then he passes to an examination of those parts attached to the underside of the car truck, after which the working of the magnet skates carried on the car is dealt with. These are excited by magnet coils, of which there are 12, connected up in series, and arranged as a shunt across the 500-volt supply terminals. It is pointed out that the resistance of the 12 coils is such that they carry at 500 volts a current of 1·9 amperes. The coils are also wound with a larger wire, and this carries the current passing through the motors, by which means the more current the motors are using the more intensely the magnet skates are magnetised, and the more forcibly the carbon contacts are held together. The length of the magnet skates is about 17 ft., but they are not magnetically continuous, each being cut into six separate lengths, and duly magnetised by one of the dozen coils mentioned. The skates do not touch the street contact plates. It is what is called the collecting skate which touches the contact plates, picking up the energy which drives the car. At this stage Mr. Lea remarks:—

"The motor and car construction generally being substantially common to all systems, I will not refer to it further than to say that if a car be fitted with the Lorain skates below, and with an ordinary trolley arm above, it can pass from the Lorain system to the trolley system, and *vice versâ*."

Many details are given as to the carbon contact armatures, and Mr. Lea states that experiments were made to show the lifting power of the armature. Mr. Lea found that the armature was able to lift a weight of 4·64 oz. besides its own weight. The weight of the armature itself is 2·75 oz., from which it is deduced that the actual lifting effort is 169 per cent. in excess of what is required to just support the armature. The excess effort ensures the armature rising with the rapidity necessary for making the stud active by the time the collecting skate arrives at the stud, or at all events, very shortly afterwards. Mr. Lea says:—

"It is, doubtless, very important in actual working that the armature should rise promptly and with certainty, but it is far more important that it should fall promptly and with the utmost certainty, otherwise the stud will remain alive at 500 volts after the car has passed away from the stud. In this connection I regard simplicity of construction and absence of friction in working as of extreme importance. I therefore call special attention to the fact that in the armature box there is only one moving part, and that there is no friction. It is true that the iron armature, the copper ribbon, the brass mount, and the carbon contact piece comprise four pieces, but they are fastened together so as to constitute only one moving part. The armature and the bottom carbon contact rise and fall slowly under the guidance of the flexible copper ribbon, and there is therefore no ifriction between moving and stationary parts to cause wear and tear, or to impede the rise and fall of the bottom carbon when the magnet skate approaches or leaves the stud box. I think I am justified in saying that there is not even a remote possibility of the bottom carbon remaining in contact with the top carbon after the car has gone by."

On the question of leakages to earth, Mr. Lea points out that salt should be used as infrequently as possible, as with cars running on tracks salted throughout there would be a considerable loss of energy. It is stated that the leakage to earth over the whole system, whether the cars are running or not, is very slight. The mean appears to be about 0·01 ampere for the length of seven-eighths of a mile of the experimental track; *pro rata* the leakage on 11·375 miles would be about 0·13 ampere, which at 500 volts represents a constant loss of only 0·87 E.H.P. over the whole system.

Several short circuits were seen, these being caused by pieces of scrap iron which had fallen from carts passing along Bilston Road. The scraps are picked up by the skates, but the interruption caused by a "short" amounted to a few seconds only. Had not the car lamps gone out the passengers would probably have been unaware of the occurrence. Mr. Lea states that such "shorts" are common to all surface contact systems on roads used for similar traffic, and they do not appear to be of any practical importance.

Attention was called to a weak spot in the underground cable—a joint—upon the soundness of which depends the exclusion of moisture from the cable terminal. He regarded the joint with some suspicion. Time only could prove whether the material would satisfactorily safeguard the joint. The expert thought it would be a great improvement if the Callender troughs did not lie under the track concrete at all.

He did not think that weather better adapted for the purpose of his inspection could have been desired. He saw the track in various conditions—from hard frost to slushy weather. In conclusion, Mr. Lea says:—

"I wish it to be distinctly understood that I do not claim to have exhaustively investigated the Lorain system, or to be in a position to predict its ultimate success or failure. I do not think that it is possible for any expert to attain such a position by looking at the system for something less than 30 days. I have called attention to all the points which have presented themselves, and I have already addressed a letter to you stating that I have not been able to discover any inherent defects which should prevent the Corporation from authorising the contractors to complete the equipment of the remaining 11 miles of route. That letter I now confirm, but I consider that the utmost care and most careful observation, and the keeping of the fullest possible records during the succeeding 12 months' trial of the system will be necessary in order that a definite conclusion may be arrived at by the time that period has elapsed. I regard the period of 12 months as being all too short for a complete investigation into the practicability of any surface contact system, beset with difficulties as it undoubtedly is."

Mr. C. E. C. Shawfield, the Corporation electrical engineer, has also issued a report on the 30 days' working of the Lorain surface contact system. He states:—

Commercial operation of the experimental line was commenced on Thursday, February 6th, about noon, a ten minutes' service being established with two cars, and maintained up to the present date. A third car has been run for a few hours on Saturdays and Sundays, and at times of heavy traffic.

The following are the particulars of the car mileage, &c., run up to 11 p.m., Friday, March 7th:—

Passengers carried	49,392
Receipts	£205 16s.
Car-miles run	4,298
Receipts per car-mile	11·49d.
Number of double journeys run	2,864
Number of journeys lost	110
Percentage of journeys lost	4½ per cent.

The causes which led to the losing of 110 double journeys may be classified as follows:—

Fifty-one journeys were lost on Saturday, February 8th, when the rails were blocked by snow owing to salt not having been used.

Forty-two journeys were lost owing to the necessity of taking the cars into the depôt for repairs and adjustments of collecting skates, gearing, brakes, &c.

Seventeen journeys were lost from various causes, such as defective paving, cars being delayed for experiments, heavy fog, &c.

During the 30 days' test I have carried out a series of experiments to obtain information on the following points:—

The mechanical strength of the boxes and their behaviour when subjected to abnormally heavy vehicular traffic.

The capability of the system to meet large demands for power without breakdown.

The effect on the system of heavy surface leakage.

The risk of electric shock to pedestrians or horses.

The tests that I applied were purposely made of an abnormal character, and the conditions produced thereby were very much more severe than any that could arise in ordinary working, but in no case did the repeated application of any test produce any visible effect on the system, or reveal any inherent defect therein.

The details and results of these tests have already been reported to the Committee, but Mr. Shawfield appends a summary of them to his report as follows:—

Test of Mechanical Strength of Boxes.

On Wednesday, January 29th, the 15-ton steam roller was run up and down the centre of the track the whole of the afternoon, either one or two wheels being constantly running over the boxes. Pieces of granite and cubes of iron were placed on the granite edges of the boxes, to concentrate the weight of the roller thereon, and to ascertain the crushing strength of the granite. The pieces of stone were in every case smashed by the roller, and the blocks of iron were visibly flattened, but very little damage was done to the boxes, some of them being unaffected, and others more or less chipped.

A similar experiment was made on Friday, February 21st, the 15-ton steam roller being run 20 times over a set of 11 boxes in front of the car shed, the boxes being carefully measured both before and after the test. All the boxes moved more or less, and several of them showed a slight permanent set or depression. The wood paving and rails were also visibly depressed by the action of the roller. On taking up the paving round one of the boxes, both the concrete itself and the granite box were perfectly sound and undamaged.

A traction engine, drawing a 28-ton fly-wheel, has also traversed over a portion of the track, but without damaging any of the boxes.

Test of Capacity to Meet Heavy Demands for Power.

On Friday, January 31st, two cars were coupled together, and one car arranged to draw the other as a trailer, the brakes being put hard-on on both cars.

Two trips were made under these conditions, and the current required by the cars varied from 100 to 125 amperes, which is equivalent to from 65 to 81 B.H.P.

I should consider that this demand for power is very much in excess of anything that would occur under working conditions.

A similar test was made on Wednesday, February 19th, but, owing to the greasy condition of the rails, it was not possible to get anything like such a heavy load.

Test for Surface Leakage.

Portions of the track in the vicinity of points and crossings were heavily salted for three days, and at the time of the test a fresh layer of salt was put down and moistened with water. Under these conditions the amount of leakage varied from 1 to 10 amperes per car. No noticeable effect was produced on the carbon contacts by the breaking of the leakage current.

Continuing his report, Mr. Shawfield says:—

Each box has been tested daily during the 30 days with a delicate instrument to ascertain whether there was any trace of electrical pressure on the top plate after the cars had passed over it, but in every case the boxes were found to be perfectly "dead," except in two instances, where a very slight pressure of rather less than one volt was discovered, this being due to the presence of a little moisture between the cup and the insulating dope.

It should be noted that many of the boxes in the Bilston Road were put in during the very wet and stormy weather just before Christmas, and some of

them were flooded with water before they were sealed up and finished. This water was not in all cases properly dried out, and in consequence of this, when current was first switched on the system seven boxes were found to be alive at pressures varying from 1 to 100 volts.

Since the line has been completed, however, and open for traffic, no box has been found "alive" sufficiently to communicate any shock to human beings or animals.

The chief trouble that has arisen in connection with the operation of the line during the 30 days' trial has been that the cars have frequently lost the current at certain places along the line, and have been unable to pick it up again until pushed along for a few feet by hand, or assisted by another car. This trouble arises from three sources:—

Firstly—The extreme unevenness of the paving along the track, the setts being in some cases higher than the tops of the boxes, and consequently preventing the collecting skate from making contact therewith.

Secondly—Certain of the boxes have been set a little too low, and are consequently missed by the collecting skate.

Thirdly—The collecting skate on the car becomes bent and distorted and fails to make proper contact throughout its whole length.

Another source of trouble that has been experienced, is the rapid wearing away of the collecting skates.

This is almost entirely due to the unevenness of the paving, the granite setts coming in contact with the skate, and cutting long strips of metal therefrom. I think, however, that an improvement could be effected in this direction by an alteration in the design of the skate. Under present conditions the life of a skate is only between 300 and 400 car miles, and consequently the cost of renewals is rather a serious matter, being something like ¼d. per car-mile.

A considerable number of short circuits have occurred every day, caused by the pieces of scrap iron which are constantly being dropped on the track. I do not, however, regard this as being of any serious importance.

The atmospheric conditions during the 30 days' trial have been severe and varied. During the first fortnight there was a large amount of frost and snow, and latterly there has been a considerable quantity of rain. Mud and slush have been plentiful throughout nearly the whole of the trial.

Having regard to the fact that I have been unable to discover any inherent defect in the system during the 30 days' trial, I am of opinion that the Corporation are quite justified in instructing the contractors to proceed with the equipment of the remainder of the 11·375 miles of single track.

I wish it to be distinctly understood that this report, together with all facts, figures or opinions expressed therein relates solely and entirely to what has occurred during the 30 days' trial which has just expired, and is not intended to deal in any way with the general question of the ultimate success or failure of the system.

As I have previously stated, it is impossible for me to say anything on that subject until I have seen the system in regular commercial operation for at least a year, and I would add that I consider the only practical basis on which a definite opinion as to the merits or demerits of the system can be formed, is its ability or otherwise to successfully withstand the heavy traffic of the approaching summer, and the frost, snow and mud of the winter 1902-3.

Woolwich.—The M.B.C. has informed the L.C.C. that it is prepared to pay one-third of an amount of £6,500 needed to acquire property to widen Wickham Lane to 50 ft. throughout for tramway purposes. The total cost of the widening will be about £36,000.

Wycombe.—A deputation from the Electric Lighting Company was recently to wait upon the Electric Light Committee of the Corporation on the subject of an electric tramway scheme which the company has proposed.

ELECTROMOBILE NOTES.

The Ajax Electric Runabout.—Our illustration from the *Scientific American* shows a type of electric motor car characteristically American, with a packing case for the battery, mounted on a tubular running gear of four wheels, and one motor driving the

The Ajax Electric Runabout.

live back axle with its two rear wheels through a differential or "jack-in-the-box" gear. Simplicity itself, but not elegant, and of very doubtful safety and durability. The battery carried on the high double elliptical carriage springs makes the whole carriage, to use a nautical expression, "very tender," in other words, top heavy. There are only 12 cells in the battery, and the total weight of the vehicle with the battery is stated to be about 1,000 lbs. This carriage is very similar to the Baker runabout electric car, the one that ran 187½ miles on one charge, round and round the boulevards of Chicago. The controller used in this car is a special adaptation of an old type, with supplemental carbon contacts for breaking the circuit at the changes, hardly necessary at all with only 12 cells. Carbon-breaking contacts are almost entirely discarded for motor car controllers in this country.

Dynamo with Distended Fields.—Messrs. Reid and Shepherd have recently patented the use of hinged pole shoes, which, they say, under centrifugal action, open or close as the speed of the dynamo is increased or reduced, to give a practically constant E.M.F. at various speeds. The small dynamo they have experimented with weighs about 11 lbs., and gives an output of approximately 4 volts, and 6 to 8 amperes, at speeds from 25 to 1,000 revolutions per minute. The armature of this dynamo, in ordinary use, remains stationary, whilst the fields revolve and carry the brushes. For use in petrol motor cars supplying the electric current for the sparking ignition in place of accumulators, the inventors have devised a special means of revolving the armature by hand in the reverse direction to the fields when starting the petrol engine; at that time the fields are only revolving at their slowest speed, and are therefore in the closest proximity to the armature. This is an interesting departure, but owing to the inefficiency of the moving magnetic joint, and the difficulty of adjusting the reaction springs to give a constant pressure, there is grave doubt as to whether any such centrifugal action would result, except in the case of the smallest type of dynamo having pole shoes of small mass and low magnetic permeability.

Motor Car Exhibition.—The Automobile Club's exhibition of motor cars is to be held at the Agricultural Hall from April 19th to April 26th, and promises to be of very special interest. Some hundreds of motor cars will be on show, and the large arena will be entirely used for carriages on view, and not, as in former exhibitions, as a running ground. The show will therefore be more on the lines of the great shows held by the Automobile Club of France, in Paris. Messrs. Cordingly have the business management of this exhibition as hitherto, but their connection with the Automobile Club's exhibition will probably cease after this show. Messrs. Cordingly have given notice of its termination in six months, as agreed between themselves and the committee of the club. A meeting of manufacturers and sellers of motor cars was held at the club on the 20th of last month, at which the question of future exhibitions was discussed. Amongst the firms of electric motor car manufacturers who attended were the British Electromobile Company, Limited, the City and Suburban Electrical Vehicle Company, Limited, the Electric Motive Force Company, Limited, and the National Motor Carriage Syndicate, Limited. It was decided to appoint a committee of 24 of the manufacturers' representatives to meet the Committee of the Club and settle as to future shows. It is to the interests of the Automobile Club to run the show for the mutual benefit of the club, of which most of the manufacturers are members, and of the trade generally, and thus adopt the policy of "The Automobile Club of France."

Electric Kitchen Cars.—The Distributing Kitchens, Limited, are inaugurating a service of kitchen cars for distributing cooked and other food in London, and as an electrical vehicle has special advantages—no heat, smell or grease—over other motors, it is considered they will be used exclusively for the purposes of the company. A light delivery van, weighing complete about 24 cwt., will run at eight miles an hour for 30 miles on one charge of energy, and is quite easily obtainable, thoroughly reliable and economical in use.

TELEGRAPH AND TELEPHONE NOTES

Cape to Cairo Telegraph.—The Berlin correspondent of the *Standard* says that according to Mr. Codrington's statement during his recent visit to Berlin, the change of the route of the German section of the Trans-African Telegraph from Capetown to Cairo to run as direct as possible to the south-west corner of Lake Victoria, is almost exclusively due to the completion of the Mombassa—Uganda Railway. The transport of the material necessary for laying the wire can now be accomplished at a much lower cost and much more speedily, as far as Lake Victoria by rail and thence to the western shore of the lake by ship, than was formerly expected.

Hastings Telephones.—Mr. Bennett's report has been received by the T.C. Telephone Committee. 1,5 0 lines are proposed and a capital outlay of £19,000. The suggested tariffs are £5 15s. per annum for unlimited service, or £3 10s. per annum with a toll of 1d. per call. The report recommends the Corporation to apply for a license, and concludes:—"With the advantages of unlimited underground construction, metallic circuits, modern instruments, and ready-made wayleave facilities, which would lie with the Corporation, doubt as to the thorough success of the undertaking cannot be reasonably entertained. The application of the tariffs I have proposed would certainly result in a substantial yearly profit, which could either be devoted to relieving the rates, or to a further reduction in telephone charges."

Pacific Cable.—The Postmaster-General of New Zealand telegraphed to Mr. Chamberlain on March 26th, notifying the completion of the first section of the Pacific cable, connecting New

Zealand with Norfolk Island and Australia. The Postmaster said:—"I send you the first message, and hope by the end of the year to have the satisfaction of cabling you *via* Vancouver." Mr. Chamberlain, in reply, telegraphed to the Governor, the Earl of Ranfurly, expressing thanks and appreciation for the "honour of receiving first message sent over Australasian section," and sharing the "hope for speedy completion of project of such importance and significance to whole Empire."

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899 ..	..
Alexandria-Larnaca	Jan. 19, 1902 ..	..
Assab-Massowah	March 17, 1902 ..	..
Perim-Obock	Feb. 26, 1902 ..	..
Cayenne-Pinheiro	March 8, 1902 ..	..
Colon-Jamaica	March 13, 1902 ..	..
Zanzibar-Mombassa	March 13, 1902 ..	..
Landlines:—		
"*Via* Hanekin" on Persian territory ..	Feb. 24, 1900 ..	..
Communication with Baranquilla and Cartagena	Dec. 8, 1900 ..	..
Guanta-Barcelona	March 17, 1902 ..	..
Berlin-Versovie	March 31, 1902 ..	..

Telegraphists for Africa.—The *Daily Mail* says that situations are offered by the Director of Military Telegraphs at Pretoria to men employed in the telegraph department of the Post Office who are willing to take service in the Transvaal. Candidates must be over 18 and under 25 years of age, unmarried, and prepared to sign an agreement to remain in the Colony for two years. They must join in all cases in the second class at £200 a year, rising by annual increments of £15 to £305. If promoted to the first class they will be paid £320 a year, rising by £20 yearly to £420. Service in the British Post Office will count towards their pensions.

Wireless Telegraphy.—The *Times* Berlin correspondent says that the question of wireless telegraphy has been receiving the serious attention of the German Government. It is said that the Imperial authorities have already discussed the matter, and a scheme is under consideration in accordance with which the chief commercial nations, especially England, France, and the United States, will be invited to send representatives to an international congress, the object of which will be to arrive at an agreement forbidding the establishment of any monopoly in wireless telegraphy on the high seas. This step, it is stated, is the direct consequence of the refusal of the Marconi station on the Nantucket lightship to enter into communication with the *Deutschland* during its homeward journey with Prince Henry of Prussia on board.

A London evening paper reports Mr. Marconi as saying that the Slaby-Arco system of wireless telegraphy infringes his patents, and declaring that he would appeal to the Courts in Germany, but for fears of the partiality of German judges. He asserts that he will prevent the establishment of any Slaby-Arco stations on British or American territory.

The *Morning Post* says that the Washington Administration has given no definite reply to the German proposal, but the President has directed General Greely, the chief of the Army Telegraph Bureau, to investigate the matter and report thereon.

A later statement says that "The company working the Braun system of wireless telegraphy is reported to have brought an action against the Slaby-Arco company for alleged infringement of patent rights, and to be claiming that both the Slaby and Marconi systems have copied their closed circuit oscillation methods. Mr. Marconi is said to have replied to this that his system was perfected four years before the Braun system."

It is also reported that Mr. Marconi has applied to the Soudan Government for permission to introduce his system of wireless telegraphy in the Soudan.

Prof. Slaby denies the statement that he based his wireless telegraphy system on any inspection of Mr. Marconi's experiments, which at the time of the inspection were incomplete.

Dalziel's Tunis representative says that the arrival there of the French flagship *St. Louis* and the destroyer *Dunois* has resulted in the discovery of a private wireless telegraphic apparatus belonging to a resident. The two ships endeavoured to communicate with the shore authorities, but their messages were intercepted by the instruments of the gentleman in question, who subsequently made himself known, and declared that he had fitted up the apparatus with the object of attempting to surprise the messages exchanged between foreign men-of-war, and particularly the British.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barcelona.—April 7th. The Port and Docks Board of Barcelona will on this date consider tenders for supply and installation of machinery, geared by electricity for the loading and unloading of merchandise, and the establishment of the necessary conduits, as well as the installation of electric light.

Bermondsey.—April 14th. Arc lamp carbons, meters, oils, incandescent lamps, cables, meter-boards and stores for the electricity and destructor works. See "Official Notices" March 28th.

Bexley.—April 21st and 28th. Tram rails, fishplates, &c., also engines, alternators, and dynamos, for the U.D.C. See "Official Notices" March 28th.

Bolton.—April 10th. Materials and stores for the Electricity Department. See "Official Notices" to-day.

Brighton.—April 14th. High-rate discharge battery, reversing booster and switchgear, for the electricity department. See "Official Notices" this week.

Bristol.—April 7th. The Electrical Committee wants tenders for a 210-kw. dynamo (for immediate delivery). Particulars may be obtained from Mr. H. Faraday Proctor, City Electrical Engineer.

Burton-on-Trent. — April 22nd. The Corporation wants tenders for the construction of about 5¾ miles of route, single line with passing places; consulting engineers, Messrs. Kincaid, Waller & Manville.

Devonport.—April 16th. Permanent way, bonding, &c., for over three miles of track for the Corporation. See "Official Notices" March 14th.

Dundee.—April 14th. Motor equipments and bogies for single deckers. See "Official Notices" to-day.

Dundee.—April 21th. Triple-expansion engine and 750-kw. dynamo for the electricity department. See "Official Notices" to-day.

Falkirk.—April 12th. Three 100-kw. steam dynamos (vertical enclosed high speed engines) for the electricity scheme. See "Official Notices" March 28th.

Glasgow.—April 7th. The Parish Council wants tenders for electric wiring. Specification, &c., on application to the engineer, Mr. W. Arnot, 79, West Regent Street, Glasgow (deposit one guinea).

Glasgow.—April 21st. Concentric and single main cables for electricity department. See "Official Notices" to-day.

Hackney.—April 9th. Three water-tube boilers, water softener, &c., for the electricity works. See "Official Notices" February 28th.

Halifax.—The Electricity Committee have this week decided to invite tenders for additional plant required for next winter. The estimate prepared by the Committee is as follows:—Two boilers, 3,200 ft. heating surface, £1,500; two superheaters, £220; two chain grate stokers, £320; steam pipes, £160; two 200-kw. rotary converters, £2,000; seven 75-kw. transformers £1,115; one high-pressure switchboard, £350; one low-pressure ditto, £225; cable, £100; contingencies, £275; total, £6,275.

Italy.—April 8th. Tenders are being invited until April 8th by the municipal authorities of Maddaloni (province of Caserta) for the establishment of a central electric lighting station in the town.

London.—April 17th. The L.C.C. wants tenders for the electric lighting of Scotland Yard Fire Station. See "Official Notices" to-day.

London.—April 22nd. The L.C.C. wants tenders for 48 miles of extra-high-pressure three-core lead-covered paper-insulated cables; 87 miles of low-pressure single ditto; and 14 miles dry core telephone cable for the tramways. See "Official Notices" to-day.

London.—April 23rd. High and low-pressure switchboards at the Grove Road generating station of the Central Electric Supply Company. See "Official Notices" March 28th.

Maidenhead.—April 4th. "Easy wiring" proposals are wanted by the E.L. Committee. See "Official Notices" March 21st.

Manchester.—April 10th. Coal and ash conveyors for the electricity department. See "Official Notices" March 28th.

Mansfield.—May 1st. Pipework, valves and tanks for the electricity works. See "Official Notices" to-day.

Oldham.—April 9th. Electrical equipment of the new car depôt at Wallshaw for the Corporation. See "Official Notices" March 28th.

Penang.—April 28th. Boilers, condenser, pumps, pipes, steam dynamos and balancer booster, switchboards, batteries, cables, junction boxes, arc and glow lamps, posts and accessories, for the commissioners of George Town. See our "Official Notices" March 14th.

Rathmines.—April 24th. 300-kw. steam dynamo, switchboard and mains. See "Official Notices" March 21st.

Rochdale. — April 8th. "Free or assisted" wiring proposals are wanted by the Corporation. See "Official Notices" March 28th.

Rotherham.—April 23rd. Rolling stock, overhead work, and permanent way, for Corporation electric tramways. See "Official Notices" March 28th.

Southampton.—April 5th. Boilers, mains, conduits, economiser, crane, and machine tools for the Electricity Department. See "Official Notices" March 21st.

Southend.—April 8th. Balancer, boosters, motor-generator, and battery switches for the Corporation. See "Official Notices" to-day.

vehicle with the battery is stated to be about 1,000 lbs. [illegible]

Spain.—April 15th. The Spanish Post and Telegraph authorities in Madrid are inviting tenders until April 15th, for the supply of 30,000 zinc cylinders for telegraph purposes. Particulars may be obtained from, and tenders are to be sent to, La Direccion General de Correos y Telegrafos, 10, Carretas, Madrid.

Spain.—April 20th. The *B. of T. Journal* last week contained notice of a call for tenders to take over and work the electric light installation of the town of Irún, which was unsuccessfully offered some months ago. Particulars at the B. of T. Offices.

Swindon.—April 23rd. Feeder and distributing cables, conduits &c., for electric lighting. See "Official Notices" to-day.

Sydney.—May 7th. Messrs. Preece & Cardew, on behalf of the Municipal Council, invite tenders for equipment of electricity works and sub-stations. Water-tube boilers, three-phase steam alternators, battery, motor-generators, stationary transformers, switchboards, &c. See "Official Notices" March 21st.

Trowbridge.—April 30th. The U.D.C. is open to receive applications for a lease of its electric lighting powers.

Warrington.—April 9th. Steel rails and permanent way work, also overhead equipment for Corporation tramways. See "Official Notices" March 14th.

West Hartlepool.—April 30th. 200 to 250-KW. engine and dynamo for the electricity works extensions. See "Official Notices" to-day.

CLOSED.

Aldershot.—The T.C. has accepted the schedules of Messrs. Venner & Co., for the supply of electrical meters, of the Reason Manufacturing Company for maximum demand indicators, and the Rochdale Electric Company for prepayment meters. The committee only proposes at present to spend about £440.

Barking.—The following tenders have been accepted by the Council for extensions to the Barking Electricity Works; engineer and manager, Mr. A. Hugh Seabrook:—

250-KW. steam dynamo (119 tenders) Messrs. Allen, with Siemens dynamo	£2,000
Switchboard extensions (11 tenders) Messrs. Dick, Kerr & Co.	340
Water meters (3 tenders) Messrs. Glenfield & Kennedy	62
Economiser, Messrs. Babcock & Wilcox, Limited..	287

The Council have applied to the L.G.B. for sanction to the borrowing of £7,570 for electricity works extensions as per engineer's estimate, as follows:—

Buildings	£375
Generating plant	4,712
Distributing ,, ...	2,455
Loan cost, &c.	28
Making	£7,570

Barnstaple Tenders.—In reference to the Barnstaple tenders which appeared on p. 478 of our March 21st issue, Messrs. Sir W. G. Armstrong, Whitworth & Co., Limited, write pointing out that their price was for combined sets including balancing apparatus, centrifugal pump, boosters, spare armature and oil filters, and not simply for dynamos as stated.

Llandudno.—The D.C. has accepted the tender of Messrs. Babcock & Wilcox, for £1,964, for two boilers and steam pipes.

Manchester.—The *Manchester Evening News* mentions that the "British Thomson-Houston Company, Limited, Head Office and Works, Rugby, have obtained the contract for 205 electrical equipments for the cars of the Manchester Corporation Tramways." This is, we believe, the largest contract for tramway equipments given at one time by any Corporation in the United Kingdom. The 205 equipments represent 410 electrical motors which are to be of the well-known British Thomson-Houston Company's G.E. 52 and 54 type, the controllers being of the same company's B. 3 type. We understand that there was severe competition for this contract.

Southend.—The British Power and Traction Company is to supply accumulators for the Corporation electric lighting works at £1,511.

FORTHCOMING EVENTS.

Monday, April 7th.—At 5 p.m. Royal Institution. General monthly meeting.

Tuesday, April 8th.—At 8 p.m. Institution of Civil Engineers. Meeting. Paper to be further discussed:—"Subaqueous Tunnelling through the Thames gravel: Baker Street and Waterloo Railway," by A. H. Haigh.

At 8 p.m. Institution of Electrical Engineers (Glasgow Section). Meeting at the Institution of Engineers and Shipbuilders in Scotland, 207, Bath Street. Paper on "Notes on the Testing of Tramway Motors, and an Investigation into their Characteristics," by M. B. Field.

Wednesday, April 9th.—At 2.30 p.m. Institution of Civil Engineers. Students' visit to Messrs. Doulton & Co.'s works, Lambeth.

Thursday, April 10th.—At 8.0 p.m. Institution of Electrical Engineers. Meeting at the Institution of Civil Engineers. "Problems of Electric Railways," by J. Swinburne and W. R. Cooper. Discussion.

Friday, April 11th.—At 8 p.m. Electro-Harmonic Society. Smoking Concert (last of the season). See "Notes" columns.

Wednesday, April 23rd.—At 8 p.m. Institution of Civil Engineers. Special meeting. Tenth "James Forrest" lecture, by Sir William C. Roberts-Austen, on "Metallurgy in Relation to Engineering."

NOTES.

The Lightning Research Committee.—This Committee, which was organised in January, 1901, for the purpose of obtaining accurate records of the action of lightning strokes on buildings, with a view to improving if possible the means of protection, has enlisted the services of over 200 competent observers in the United Kingdom and a considerable number abroad. The heavy thunderstorms of last year afforded observers numerous opportunities of investigating and recording, upon lines laid down by the Committee, the damage caused by lightning to buildings within their area of observation. The net result so far is a series of some 70 or more trustworthy records made by persons on the spot and as nearly as possible at the time of occurrence. Supplemented as they in many cases are by information on points pertinent to the inquiry, these records furnish promising material for the Committee to work upon when sufficient data have been collected to enable them to formulate their conclusions. Particularly interesting and helpful are the photographs, plans, and sketches which illustrate some of the records. Photographs are often found to reveal conditions which verbal description fails to represent, or which would pass unnoticed except by the expert. The Committee therefore make a point of getting photographs immediately after the occurrence of a disaster in cases of importance. Out of 60 cases tabulated by the Committee up to the end of December, 1901, no fewer than 12 relate to buildings fitted with some form of lightning conductor. As regards the system recommended by the Lightning Rod Conference of 1882, data to hand are not at present complete enough to afford a practical test of its efficacy. The recently issued report, however, of H.M. Inspectors of Explosives goes to show that the system has been found wanting, and that there is ample justification for the present inquiry. Commenting upon recent accidents caused by lightning to the factories of the Nobel Explosives Company at Krummel and Hamm, Germany, the Inspectors state that "these accidents have done much to confirm a feeling of distrust which has for some time been growing in our minds as to the absoluteness of the protection afforded by conductors erected in accordance with specifications laid down by the Lightning Rod Conference of 1882; and they go far to confirm on a large scale the interesting and instructive laboratory experiments of Dr. Oliver Lodge."

Motor Speed Trials.—A large number of members of the Automobile Club renewed their acquaintance with the county of Norfolk during the Easter holidays by a tour to Cromer. By permission of Lord Suffield, some speed trials took place on Saturday in Gunton Park before a large and fashionable gathering. There were between 50 and 60 motor cars and motor cycles of almost every description in the park, but only 20 motorists took part in the trials. The course, along a road in the park, was marked off for a flying kilometre and a flying mile, with several sharp corners and inclines. The actual speed results will not be made public until the Whitsun outing of the club, but it was ascertained that the more powerful motors attained as high as 60 miles an hour. Mr. S. F. Edge's 50-H.P. Napier did the highest speed. Among the visitors were Mr. R. Wallace, chairman of the club, with a Motor Manufacturing Company's car. The Panhard type was represented by Mr. Harvey du Cros on a 16-H.P.; Mr. J. E. Hutton, 10 H.P.; Mr. E. de Wilton, 7 H.P.; Mr. R. Bird, with a 24-H.P. Morse, and Mr. Graham White, 10-H.P. Morse; Mr. W. D. Astell and Mr. C. L. Freestone each with a New Orleans; Mr. J. A. Holder on a high power Lanchester; Mr. G. H. Burford, 24-H.P. Milnes. In addition there were two Meisse steam cars, the only two of their kind in the United Kingdom. The smaller of these did 1 mile in 2 minutes 5 seconds.

Battersea Polytechnic.—A conversazione was held in the engineering department on Saturday, March 22nd, to mark the opening of new engineering rooms, and in connection with the Polytechnic Engineering Society. A recent extension of the building has given new laboratories for mechanical and electrical engineering and more drawing office and workshop accommodation. During the evening a meeting was held, when Sir Alexander Binnie formally declared the rooms open and spoke of the value of technical training to the young engineer. Among those who also took part in the meeting were Mr. Charles Hawksley, the President of the Institution of Civil Engineers; Sir John Jackson, the President of the Institution of Junior Engineers; Prof. Unwin, F.R.S.; Dr. Garnett, secretary of the Technical Board; and Principal Wells. The expense of the building and equipment has been met by grants

from the Technical Education Board of the London County Council. The conversazione was very largely attended, and included an interesting exhibition of engineering machine tools and other apparatus lent by different makers, and a good collection of models lent by the Society of Model Engineers, the Electrical Company, Limited, Messrs. B. J. Hall & Co., the Daimler Motor Company, the International Pneumatic Tool Company, Limited, Messrs. C. A. Parsons & Co, engineers, Mr. W. H. Harling, Messrs. Smith and Stevens, Prof. W. E. Dalby, M.A., Messrs. Charles Nurse & Co., Messrs. Charles Churchill & Co.

The Erith Engine.—We have received a copy of a report by Prof. Ewing on tests made by him on a steam engine at Messrs. Easton & Co.'s works at Erith. The engine was only small, of triple expansion type, running at 400 revolutions per minute. It has three cranks, and two cylinders over each crank, or six cylinders in all. Steam first enters one of the upper cylinders, passes to the other two upper cylinders, which act as intermediates, and finally to the three low pressure bottom cylinders. All the top cylinders are 12 in. diameter, and the lower cylinders are 16 in. diameter; the stroke of all is 8 in. The cylinder ratios are thus about 1 : 2 : 5·3. The steam valves are of piston type, in three lines, with a cut-off valve to the H.P. cylinder, automatically controlled from a shaft governor. Positive oil-pump lubrication is provided in enclosed casing to crosshead, pin, and shaft bearings. The engine is double acting, and was run with a surface condenser and air pump, which required 4½ KW. to drive it. The special point was the high superheat on the Schmidt system. The superheater was in the boiler flue. Close to the engine the temperature ranged from 350° C. up to 380° C., or from 662° to 716° F., with a pressure of 130 lbs. per sq. in., the saturation temperature being 356° F., so that the superheat ranged up to 360° F. Of this about 115° to 120° was given up to the low pressure steam in the receiver, and the highest temperature that reached the high pressure cylinder was only 600°. Four trials were made at 41·2, 67·3, 104 and 140·2 KW. output, and showed a steam consumption per KW.-hour of 24·4, 20·3, 18·5 and 18·3 lbs., the stop valve temperatures being 666°, 694°, 700° and 709° F., and steam entering the H.P. cylinder at 559°, 568°, 581° and 601°. Steam left the I.P. cylinder at 245°, 250°, 263° and 286°, but was heated up before entering the L.P. cylinders to 345°, 363°, 380° and 397°, or very considerably superheated. In fact, at no point was steam wet or not superheated, but we should like to have had the temperature of the final exhaust. In no case was the vacuum so high as 24 in., and from 140 to 104 KW. the steam consumption was practically identical, and not above 18½ lbs., which probably represents not more than 11½ lbs. per I.H P.-hour, a sufficiently good result. The overall efficiency appeared to be 83 per cent. at maximum load. The results show what can be expected from the judicious application of superheated steam, whereby alone the mischievous action of the interior cylinder surfaces can be successfully combatted. The employment of the receiver as a moderator of the high intensity of superheat and its transfer to the L.P. steam seems to us rather happy. Even at 41·2 KW. output, the steam consumption was only 24·4 lbs. per hour, or about 33 per cent. above the full load consumption; but at only 10 KW., or one-fourteenth of full load, the consumption ran up to 66·3 lbs., but the initial superheat was only to 563° in that case. Considering that the boiler pressure was only 130 lbs., the results are very good throughout, and we would emphasise the fact that the steam consumption remained low over so wide a range of power because it is so very largely due to cylinder condensation that bad results are obtained from underloaded engines. In electrical traction work especially there is always so much low power running that the advantages of superheating should be carefully studied by all engineers who wish to secure economy.

Personal.—Mr. J. McMahon, chief engineer to the Blackpool and Fleetwood Tramroad Company, was last week presented by the employés of the company with a handsome tea service as a wedding gift.

It is announced that the Postmaster-General has appointed Mr. J. Gavey, member of the Institution of Civil Engineers, to be engineer-in-chief of the Post Office on the approaching retirement of Mr. J. Hookey. We tender to Mr. Gavey our hearty congratulations. It is appropriate to remark in connection with Mr. Gavey's promotion, that he has seen something like 42 years' active service in the telegraphic system of the kingdom. He was taken over by the State from the old company at the time of the purchase in 1870. He has invented and introduced important apparatus for use in telegraphy and telephony during his lengthy practical experience, and the work which devolved upon him a few years ago when the Post Office took over the trunk telephone lines, and carried out the extension of the system, as well as the laying out of the London Post Office system just opened, has been great both in volume and value. If ever any man were qualified, from every point of view, for a particular position, Mr. John Gavey is so for the office of engineer-in-chief for the Postal Telegraphic and Telephonic services of the United Kingdom. In addition to his many excellent qualifications as a practical electrical engineer, Mr. Gavey is possessed of other sterling personal qualities, which eminently fit him for so prominent a post, and go such a long way toward ensuring the smooth, efficient, and generally satisfactory working of such a department of the public service.

Mr. J. M. Carr, who for 8½ years has been associated with the electrical department of Messrs. Wylie & Lockhead, Limited, of Glasgow, as manager, has been appointed Scottish representative of the Samuel Barnes Electric Company, of London. On March 28th he was presented with a silver tea service by his old friends. Mr. Carr's address will be 19, Waterloo Street, Glasgow.

We learn that the Board of the Amazon Telegraph Company has appointed Mr. Edward Stallibrass, A.M.I.C.E., its general manager and engineer in Brazil. We have had the pleasure of knowing Mr. Stallibrass for many years, and we consider that the company is to be congratulated on having engaged a gentleman of such sterling worth and ability.

The Cork Exhibition.—The *Times* correspondent at Cork says that it is not expected that the Cork International Exhibition will be nearly completed on May 1st, the date fixed for the opening ceremony. The workmen are mainly responsible for this; and latterly a number of strikes among them have only been averted by conceding to them every demand made, no matter how absurd. Foreign exhibitors, too, are already wishing they had not come to Cork, owing to the treatment they have received from local mechanics, who refuse to permit them to fix up their stalls, saw wood, drive nails, or do any other such trifling work, on the ground that they are not skilled workmen. In some instances notices of legal proceedings have been served upon the executive committee by these exhibitors, who have been subjected to insult and even physical violence.

Serious Accident to "Meteor."—When the above announcement on the poster of that glorious orb of day, edited by Dan Leno and Herbert Campbell, caught our observant optic, our editorial heart sank within us. Could it be that the friend of our youth, the "Meteor" we love, had become a victim to Mr. Trotter's wiles? We had all along feared a shock of this kind; and investing that modest coin of the realm which purchases the central body of the solar system, we prepared ourselves for the worst. Happily our fears were unfounded. The mishap had occurred to the German Emperor's yacht, not to our very own "Meteor," and we breathed again.

A Water Company and Electrical Competition.—A point of some interest to the electrical industry arose in the course of an arbitration which came to a close in London recently, for the purpose of determining the price which is to be paid by the Airdrie, Coatbridge and District Water Trustees for the undertaking of the local water company. The company claimed over half a million sterling, whilst the water trustees sought to obtain the concern for about £320,000. Amongst several considerations urged by the proposed purchasers, in depreciation of the value of the undertaking, was the contention that the advent of electrical energy into the district, under the Clyde Valley Electric Supply Act of last year, would tend to greatly diminish the demand for water for trade purposes in a locality that was primarily and essentially a manufacturing one, and would so reduce the revenue of the water concern. Mr. James Watson, water engineer to the Corporation of Bradford, said that at one time there were in that city from 140 to 150 "lifts" and "jiggers" used for raising timber by hydraulic power, but that in consequence of the Electricity Department having "collared" this trade by substituting electric for hydraulic energy, the water authority had been docked of over £2,500 of this branch of their water revenue. Electric motors were also being fitted to much of the machinery hitherto driven by steam in Bradford engineering shops, and as a result the receipts of the water authority would be still further reduced. The whole trend of the times, he added, was to substitute electric motors for steam-driven machinery, and correspondingly to diminish the trade demand for water. Mr. Robertson, of the firm of Strain & Robertson, electrical engineers to the promoters of the Clyde Valley scheme, gave some details as to the scope of the undertaking, and as to the intentions of the company which last year's Act incorporated. The district here in question was, he said, within the company's area of supply, and one of their generating stations would be within six miles of Airdrie and Coatbridge. They had surveyed the sites for their stations, they had issued the contractors' specification, and they expected the tenders would be in in the course of the following week. They had not yet taken any steps for the raising of capital, as their first object was to obtain definite information as to the amount necessary; and, moreover, the promoters were such a strong body, consisting for the most part of owners of large works in the district, that they had not decided whether they should not raise the capital from among themselves without going to the public at all. The district was one which lent itself peculiarly to the utilisation of electrical energy, and when their works were established they looked forward to giving a large supply. The inevitable result would be to materially diminish the demand for water for steam-raising purposes.

The Production of Aluminium.—Messrs. Haber and Geipert have recently published an account of some experiments on the Héroult-Hall process of winning aluminium. As a furnace, they employed a block of artificial carbon hollowed out and standing on a copper plate, which was connected with the source of current. The anode was a carbon rod. Finding that natural cryolite gave less satisfactory results, they prepared an artificial solvent composed of 96·3 per cent. of aluminium fluoride and 3·4 per cent. of sodium fluoride; and for their alumina they used a very pure material testing alumina, 99 per cent.; silica, 0·18 per cent.; ferric oxide, 0·035 per cent.; and sodium oxide, 0·5 per cent. The mixture was fused by means of an arc, and then electrolysis was continued with a current of 300 to 400 amperes at 7 to 10 volts, the current density being 3 amperes per sq. cm. The process went on very smoothly, further quantities of alumina, and also of cryolite, being added at intervals. Provided sufficient amounts of alumina were present, the voltage kept low; but it was necessary to avoid having an excess of aluminium oxide, as otherwise the density of the bath rose to such an extent that the reduced aluminium did not sink properly to the

Field.

The expense of the building and equipment has been met by grants

bottom of the cell. After a few hours' working, some 200 to 250 grammes of aluminium were recovered from 2 or 3 kilos. of charge, the yield being 54 per cent. of the theoretical. The losses by volatilisation, spitting, &c., were under 11 per cent. The best proportions for the electrolyte were found to be equal parts by weight of sodium fluoride, aluminium fluoride, and alumina. The metal won was very pure, containing 0·05 per cent. of carbon, 0·034 per cent. of silicon, and traces of iron and sodium. Its mechanical tests agreed with those of pure aluminium.

Our Decayed Canals.—We are, and long have been, in complete sympathy with the objects advanced by Mr. Cawley in his pamphlet on the future of British canals, in which he has reprinted certain letters written by him to the *Manchester Guardian*. The decadence of our canals is due entirely to their being practically owned and wholly controlled by the railway interest, which decided years ago to kill all canal opposition, and has done so, and does not, to use Mr. Cawley's words, hesitate to insult the intelligence of business men by quoting 20s. per ton for conveying, on the Shropshire Union Canal, hardware to Liverpool, a distance of 85 miles, whereas salt is carried the 35 miles from Northwich to Liverpool on a free waterway for 1s. 4d. per ton. So much for the policy of railway control. Though the Manchester Ship Canal has not yet become a commercial success, it has been a magnificent investment for Lancashire and Manchester; that city, actually decadent for some years onward from 1877, has taken a new lease of prosperity, very largely owing to the Ship Canal. Mr. Cawley calls for a Royal Commission to investigate the whole matter. He thinks Royal Commissions are better than they once were. Something should, at any rate, be done. Our railways are badly managed to begin with. No attention is given to the welfare of the country, while everything is done to aid the foreign importer by preferential rates in his favour. The railways have, in fact, always aimed rather to pay dividends by squeezing the utmost possible out of the public than by improving facilities and developing trade, and they have sought to secure these ends by choking the canals. Much good might be done with the canals were they cared for. A very small expenditure at one or two points would vastly increase their utility. Power traction has scarcely been attempted, though where it has, as on the Leeds and Liverpool, it has, we believe, proved a success. But there can be no success of a real kind where rates are as high as on the rails. Is it not a fact that the canals are used by the railway companies at a profit of even hundreds per cent., goods going by canal that pay the very heaviest railway charges? The canals ought to be free and independent. Carriage by canal is cheap. Electricity in France affords a means of canal traction that has been largely employed, and there is no reason why the same should not be the case here. Winter is so usually mild that were traffic properly fostered there would be no real stoppage due to ice, which can be dealt with in all English winters. Even after all allowance is made for short haul and proper terminal charges our railway rates are very excessive. This is simply because there is no competition, and railways have not been put on their mettle to find improved methods of carrying on business. It is curiously characteristic of railway policy that while they can always effect combinations having for their object the further charging of the public, one never finds a combination to help public business. Canals have not been neglected on the Continent of Europe, where they help to keep down railway expenses, and even in America where railways carry goods cheaply, the canals seem to live and to be necessary, despite America's winter climate, which is enough to stop canal traffic. Only in England have canals ceased to exist as a public aid, and this solely because of the alligator jaws of the railways which have gripped them. Free the canals, and others would be built. So much was expected of railways at one time that it is amusing to read their history; the railways were to cheapen carriage and so on. Too often they charge more than the old road wagons of 70 years ago, and some of our South country lines are certainly as slow as the old express boats on the canals.

Electric Power for Cotton Mill Driving.—As an example of what a technical writer should avoid, we may name an article by one W. B. Smith Whaley, in *Cassier's Magazine*, on "Electric Power in American Mills." In one place we are told that a mill of 10,000 spindles was once considered large in the Southern States, but now factories are as large as 30,000 or 40,000 spindles. Then we are shown a picture of a very large factory that must surely hold many more than this number of spindles, and are told it has a power plant of 6,000 H.P., which, of course, would drive about 300,000 spindles; later, after wondering how so much power can possibly be required, we are told that the 6,000 H.P. also serves two other cotton factories, a tramway, and some lighting. Presuming that one-third the plant is idle, the power is still large even for three factories and a tramway. The article is simply a piece of special pleading for the electrical driving of cotton mills, by a man who claims to have been peculiarly and largely identified with the subject, yet not a single figure of any value to an engineer is afforded throughout the article. Mere unscaled block plans of mills driven are useless. We all know that mills a mile square can be driven if necessary. What we want to know are the total powers installed per 1,000 spindles, the arrangement of motors singly or on the group system, the sort of motor employed, the voltage, and so on. All we are really shown are two enclosed motors bolted to the ceiling, but not a single useful figure. We are prying, it may be, into the author's special knowledge? If this be so, we reply that the author's article should not appear in the pages of a technical magazine, but in some corner of a Saturday paper. The electrical driving of a cotton factory is, undoubtedly, likely to be an economy where there is water power available. It may even pay where steam power must be installed to produce the electricity, but of that in the Olympia mills referred to, there is no information, especially as the plant sells power to other users. All we are told is that there is a saving in friction of 20 per cent., and that the output is 4 per cent. greater from the machinery because of steadier turning than that given by belts or ropes. This latter statement is a little doubtful. It is easy to detect unsteady turning by the ear alone and the hum of the spindles, and the note in a well-driven cotton factory in England is uniform. Electrical driving of cotton mills of large size will be a difficult matter to cope with as regards coal-generated electricity. An electric drive, as illustrated in the article before us, does nothing to improve the appearance of a factory, now rope driven, for it simply adds the motor and removes nothing from sight to compensate for the addition. It would be different where every machine had its own motor, and we have seen rooms in Lancashire factories belt-driven from below in which, of course, not a belt was visible. We raise these various points because we think broad statements without any supporting statistics are detrimental to the cause advocated; opponents scoff at them.

Electro-Harmonic Society.—The final smoking concert of the season will be held at the St. James's Hall Restaurant (Banqueting Hall), on Friday evening next, April 11th, 1902, at 8 o'clock precisely. The programme includes vocal music by Messrs. Henry Beaumont and George Stubbs; instrumental music by the orchestra, Mr. Alfred E. Izard, and Mr. T. E. Gatehouse; Mr. W. G Churcher will give humorous recitations, Mr. Will Edwards humorous songs, and Dr. Byrd-Page conjuring manifestations.

The Factory Act and Electric Generating Stations.—The *London Gazette* for April 1st contained an announcement to the effect that an order has been made exempting those parts of electric generating works "in which the number of cubic feet of space bears to the number of persons employed therein at one time, a proportion not less than 2,500 to every person," from the provisions of Sec. 1 of the Factory and Workshop Act, 1901, as to limewashing.

Lecture.—Before the Nottingham Guild of Engineers, on 25th ult., Mr. H. Vickerstaffe delivered an address upon "Electrical Appliances."

Business Announcements.—Messrs. Mackies, Limited, shafting, pulley and saw-bench manufacturers, of Reading, have placed their London and district representation in the hands of Mr. J. E. Lawler, of 39, Lime Street, E.C. The company make a speciality of dynamo pulleys and other fittings for electrical work. Communications should be addressed to the London office.

Appointment Vacant.—The Halifax Tramways Committee wants a superintendent of overhead construction work at a salary of £150 per annum.

Institution of Electrical Engineers (Students' Section).—In consequence of the visit of the Students' Section to Newcastle, the meeting for April 9th has been postponed to April 30th. Students travelling from London, leave by the 10 a.m. from King's Cross for Newcastle, on Monday, April 7th.

THE CENTRAL STATION ENGINEER.

The Woolwich Borough Council has increased the salaries of the electrical staff as follows:—Mr. J. B. Mitchell, engineer, from £400 to £500; Mr. G. W. Keats, chief assistant, £125 to £150; Mr. S. H. Penning, junior assistant, £80 to £105.

Mr. G. E. Sanders, assistant electrical engineer and station superintendent to the Borough of Bedford, was the recipient last week of a silver-mounted walking-stick from the men at the works, as a token of esteem. The staff presented him with a pocket-case and a standard book on electricity. Mr. C. Barkham, the assistant engineer, in the absence of the chief engineer, asked Mr. Sanders to accept these small gifts in recognition of his valuable services to the Borough. Mr. Sanders has been appointed assistant electrical engineer to the Borough of Hampstead, and has taken up his duties.

Mr. J. B. M'Indoe, resident manager of the Scottish House-to-House Electricity Company, Limited, who is now leaving that company's service, was entertained by the employés at Coatbridge on March 21st. The workmen presented him with a non-magnetic chronograph watch.

On Tuesday evening last week the staff and employés of the Blackpool Corporation electricity works made presentations to Mr. R. C. Quin, their late manager, and Mr. J. W. Speight, the late deputy manager, prior to their departure to London to take up consulting work. Mr. W. W. Parkinson, the senior assistant engineer, on behalf of his colleagues, presented Mr. Quin with a handsome oak sideboard. The presentation of a marble clock and bronze figures to Mr. Speight was made by Mr. A. D. Murdock. Mr. Quin and Mr. Speight feelingly responded.

A smoking concert was held recently by the staff of the Bath Corporation electricity works at the Talbot Hotel. Mr. C. A. Nethercot was in the chair. During the evening Mr. A. H. Snewin presented the city electrical engineer (Mr. Francis Teague) with a handsome oak smoker's cabinet, on behalf of the

Carr's address will be 19, Waterloo Street, Glasgow.

an extent that the reduced aluminium did not sink properly to the

staff. Mr. Snewin mentioned that during the 12 months Mr. Teague had been in Bath he had won the esteem of the whole of the staff. On behalf of the staff he wished him every success in the scheme he is about to carry out. Mr. Teague said he was completely taken by surprise at the gift, and after thanking the men most heartily, remarked that he felt confident of making the undertaking a success if the men would help him in the future as they had done in the past.

NEW COMPANIES REGISTERED.

C. Muller, Limited (73,181).—This company was registered on March 22nd, with a capital of £5,000 in £1 shares, to acquire the business of manufacturers of and dealers in surgical instruments and dealers in vulcanite, ebonite, india-rubber and metal goods carried on at 64-5, Holborn Viaduct, E.C., as C. Müller, to adopt an agreement between A. M. Edelstein and S. Strauss, and to carry on the same and the business of manufacturers of and dealers in medical appliances, optical, electrical and scientific instruments, &c. The first subscribers are:—S. Strauss, 10, Lyndhurst Gardens, N.W., diamond merchant, with 500 shares; A. M. Edelstein, 23, Greencroft Gardens, N.W., merchant, 500 shares: Mrs. L. Strauss, 10 Lyndhurst Gardens, N.W., with one share; J. Curtis, 56, Lamb's Conduit Street, W.C., clerk, with one share; F. C. Beard, 55, Avondale Road, S.E., clerk, with one share; Mrs. B. Edelstein, 23, Greencroft Gardens, N.W., with one share; Miss E. Edelstein, 23, Greencroft Gardens, N.W., with one share. No inital public issue. The number of directors is not to be less than two nor more than five; the first are S. Strauss and A. M. Edelstein; qualification, 200 shares; remuneration as fixed by the company. Registered office, 64-5, Holborn Viaduct, E.C.

Gloucestershire Electric Power Syndicate, Limited (73,184). This company was registered on March 22nd, with a capital of £7,500 in 75 ordinary shares of £100 each and 600 deferred shares of 1s. each, to carry on in the County of Gloucester or elsewhere the business of an electric power supply company and of electricians, electrical, metallurgical mechanical and general engineers, &c., and to adopt an agreement with T. N. A. Grove. The first seven subscribers are:—A. Thorne, 11, Austin Friars, E.C., chairman of National Explosives Company, Limited, with one ordinary share and four preference shares; J. D. Robertson, 3, Copthall Buildings, E.C., manager, with two ordinary and eight preference shares: D. Fox, Marlborough House, Dewsbury, J.P., with one ordinary share and four preference shares; F. Winterbotham, Stroud, Gloucester, solicitor, with one ordinary share and 79 preference shares; Sir W. H. Marling, Bart., Stanley Park, Stroud, with one ordinary share and four preference shares; W. J. P. Marling, Stanley Park, Stroud, with one ordinary share and four preference shares; and A. S. Winterbotham, Cam, near Dursley, Gloucestershire, manufacturer, with one ordinary share and four preference shares. No initial public issue. The number of directors is not to be less than three nor more than 11; the subscribers are to appoint the first; remuneration as fixed by the company. Registered office, 5, Rowcroft, Stroud, Gloucestershire.

Dewhurst's Engineering Company, Limited (73,205).—This company was registered on March 25th, with a capital of £10,000 in £1 shares, to acquire the businesses and undertakings of mechanical and electrical engineers, iron and steel merchants, and colliery and general mill furnishers now carried on by the executors of the late Michael Hunter, trading as John Dewhurst and Son, at 68, 70, 72, and 74, Attercliffe Road, Sheffield, to adopt an agreement made between Martha Hunter and M. J. Hunter of the one part and J. H. Dewhurst of the other part, and to carry on the business of an electric light company in all its branches, mechanical engineers, ironfounders, tool makers, brass founders, metal workers, millwrights, colliery and mill furnishers, tin plate makers, &c. The first subscribers are:—J. H. Dewhurst, 6, Sheldon Road, Sheffield, engineer, 1,000 shares; B. J. Davy, 20A, Goddard Hall Road, Sheffield, engineer, 1,000 shares; W. V. Davy, 20A, Goddard Hall, Road, Sheffield, foreman moulder, 1 share; G. Longden, 28, Burcot Road, Meersbrook, Sheffield, engineers' manager, 1 share; J. W. Allbrighton, 77, Dearne Street, Brightside, Sheffield, clerk, 1 share; J. Booth, 205, Shoreham Street, Sheffield, electrician, 1 share; and J. Maxfield, Authorpe House, Wadsley Bridge, 1 share. No initial public issue. The number of directors is not to be less than two nor more than three; the first are J. H. Dewhurst and B. J. Davy, managing director and assistant managing director respectively; qualification, £100; remuneration of J. H. Dewhurst, £500 per annum, of B. J. Davy, £200.

Harboune Electrical Manufacturing Company, Limited (73,208).—This company was registered on March 25th, with a capital of £1,000 in £1 shares, to carry on the business of manufacturers of and dealers in electrical fittings and fixtures of all kinds, and to acquire and turn to account any patents. The first subscribers (each with one share) are:—P. Pakeman, 11, Ironmonger Lane, E.C., clerk; R. B. Cannings, 81, Camilda Road, South Bermondsey, clerk; J. E. Simister, 33, Clements Road, East Ham, clerk; A. W. Read, 11, Ironmonger Lane, solicitor; G. Rowton, 5, Buxton Terrace, South Leyton, clerk; E. Clare, 1, Walker Street, Limehouse, clerk; H. M. Cordrey, 26, Armett Road, East Dulwich, clerk. No initial public issue. Registered without articles of association.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Central Electric Supply Company, Limited (53,080). — This company's annual return was filed on February 18th, when the entire capital of £100,000 in £5 shares had been taken up and paid in full. Mortgages and charges, £250,000 (4 per cent. guaranteed debenture stock).

Particulars of registered mortgages and charges.—Date of trust deed: July 2nd, 1901. Amount secured by debenture stock: £250,000. Date of resolution creating debenture stock: July 2nd, 1901. Amount and date of issue: £250,000, July 2nd, 1901. Property charged:—(1) The undertaking and property of the company, present and future, other than the "specially mortgaged premises"—See (2). (2) A covenant to execute a charge on the "specially mortgaged premises," being certain land containing about 7 acres near Grove Road, Marylebone, on which a generating station is in course of erection, except so much of the said land as the company is under an obligation to dedicate to the public. Trustees: The Hon. G. Lyttleton, K.C., and Sir C. Grant, K.C.S.I.

Adams-Randall Telephone Patents Company, Limited (61,477).—This company's annual return was filed on January 20th, when 50,000 ordinary and 2,300 preference shares were taken up out of a nominal capital of £60,000 in 50,000 ordinary and 10,000 6 per cent. cumulative preference shares of £1 each. £1 per share has been called up on 2,300 preference and 7 ordinary, resulting in the receipt of £2,282. £25 remains in arrears. 49,993 ordinary shares are considered as fully paid. Mortgages and charges, £9,200.

Costa Rica Electric Light and Traction Company, Limited (56,447).—This company's annual return was filed on January 13th, when the entire capital of £130,000 in £1 shares had been taken up. £7 paid. £129,993 considered as paid. Mortgages and charges, £145,803 6s. 8d.

Mutual Telephone Company, Limited (56,627).—This company's annual return was filed on January 27th, when 6,283 preference, and 10,183 ordinary shares were taken up out of a nominal capital of £250,000 in 20,000 5 per cent. cumulative preference and 80,000 ordinary shares of £5 each. 6d. per share has been called up, and £1,102 15s. has been received, including cash paid in advance. No mortgages or charges.

Direct United States Cable Company, Limited (11,597).—This company's annual return was filed on February 19th, when 60,710 shares were taken up out of a nominal capital of £1,800,000 in 65,000 shares of £20 each. £1,214,200 is considered as paid. No mortgages or charges.

SUPPLY STATION ACCOUNTS.

Worcester Corporation Electricity Accounts.

The accounts of the Worcester Corporation electricity department are as usual amongst the earliest issued, and give a favourable impression. Mr. C. J. Sutherland, the city electrical engineer, is to be congratulated upon being able to show a net profit of £1,385, after paying financial charges. He states that the output would have increased even more rapidly than has been the case had the "free lamp system" not been given up. His argument is that a customer supplied with lamps free replaces one when it has burnt out; but if they have to be purchased, the replacing of a lamp is often neglected, and as a result less units are used. This, it seems to us, is a rather far-fetched notion. 23 customers have been "free-wired" on the Corporation's own system, and of these 14 were connected in 1901. The new generating station on the low-pressure three-wire system has been proceeded with, and should be ready for opening by the end of this year. The usual course of leaving the designs in the hands of the electrical engineer has been adopted, and will, we anticipate, prove entirely satisfactory.

GENERAL STATEMENT.

	1900.	1901.	Inc.
Total capital expenditure ...	£82,630	£88,879	£6,249
Number of units sold	625,739	662,569	36,830
Number of lamps connected ...	34,494	36,242	1,748
Maximum load in kilowatts ...	510	538	28
Gross revenue	£9,669	£10,856	£1,187
Gross expenditure	£5,999	£5,326	— £673
Gross profit	£3,670	£5,530	£1,860
Average price per unit sold ...	3·57d.	3·76d.	·19d.

There has been an increase of over 18 per cent. in the units supplied to public lamps, but the total increase only amounts to 5·88 per cent., as the private customers' consumption was augmented only by 3¼ per cent., as compared with 17⅝ per cent. in 1900. Trade depression is held to explain this, as also an increase in number of consumers of only 38, against 69 the previous year; the lamps connected rose by 1,748, as against 3,292. The mean price per unit increased from 3·57d. to 3·76d., but taking private supply only, the figures were 4·48d. to 4·75d.

REVENUE STATEMENT.

	1900. Gross.	1900. Per unit.	1901. Gross.	1901. Per unit.	Inc.
Sale of energy	£9,314	3·57d.	£10,392	3·76d.	+ ·19d.
Meter rents	220	·09d.	239	·09d.	·00d.
Sale of old material, &c. ..	34	·01d.	26	·01d.	·00d.
Sundry fees, rents, and compensation, &c.	101	·04d.	199	·07d.	+ ·03d.
Gross revenue ...	£9,669	3·71d.	£10,856	3·93d.	+ ·22d.

The output was distributed as follows:—

Year.	Units generated.	Private supply.	Public lighting.	Number of public lamps.
1899 ...	710,416	441,837	109,600	57 arcs, 3 inc'ts.
1900 ...	842,132	519,690	106,049	57 arcs, 16 inc'ts.
1901 ...	907,086	536,691	125,878	57 arcs, 139 inc'ts.

The waterworks motors accounted for 144,432 units and private motors for 2,466 units.

The reduction in cost of coal has been due to a lower price, resulting in a saving of £326; the weight burnt was 2,516 tons against 2,157 tons in 1900, the increase being caused by an exceptionally dry season (the worst in this respect since the works were opened). The new generating plant has saved steam, as is shown by a reduction from 11·27 lbs. to 9·88 lbs. per unit steam generated. The items in the cost sheet have gone down with the exception of "repairs," due chiefly to extra work on the mains and special repairs to an alternator covered by insurance, and "rates" on property. Taking wages and repairs together the drop

electrical driving of a cotton factory is, undoubtedly, likely to be an economy where there is water power available. It may even

SNEWIN presented the city electrical engineer (Mr. FRANCIS TEAGUE) with a handsome oak smoker's cabinet, on behalf of the

is $\frac{1}{20}$d. The reductions of nearly $\frac{1}{4}$d. on works cost and over $\frac{1}{3}$d. on total costs are most satisfactory and leave the latter at a figure well under 2d. per unit.

COST OF PRODUCTION.

	1900. Gross.	Per unit.	1901. Gross.	Per unit.	Inc.
Coal..	£2,678	1·03d.	£2,351	**·85d.**	−·18d.
Oil, waste, water, and engine room stores.	217	·08d.	182	**·07d.**	−·01d.
Salaries and wages incurred in generation and distribution, and attending, &c., street lamps.	1,373	·53d.	1,011	**·37d.**	−·16d.
Repairs and maintenance of buildings, boilers, engines, dynamos, and repairs public lamps.	593	·22d.	917	**·33d.**	+·11d.
Works cost ...	£4,861	1·86d.	£4,461	**1·62d.**	−·24d.
Rent, rates and taxes ..	88	·03d.	112	**·04d.**	+·01d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	481	·19d.	504	**·18d.**	−·01d.
General establishment charges, stationery and printing, law charges and insurance.	170	·07d.	173	**·06d.**	−·01d.
Other expenses: Compensation, free wiring, lamps, &c.	399	·15d.	76	**·03d.**	−·12d.
Total costs ...	£5,999	2·30d.	£5,326	**1·93d.**	−·37d.

The reduction in gross costs by £673, coupled with an increase in revenue of £1,187, brings the gross profits up by £1,860. Against this the financial charges only increased by £479, so that the net profit is augmented by no less than a sum of £1,381.

PROFIT STATEMENT.

	1900.	1901.
Interest on loans	£1,945	£2,247
Sinking fund for repayments	1,721	1,898
Net profit carried forward	4	1,385
Gross profit	£3,670	£5,530

CITY NOTES.

High Wycombe (Borough) Electric Light and Power Company.

THE annual meeting was held on 21st ult., Mr. A. Slatter, M.I.C.E., presiding. The report showed that, for the year ended December 31st, steady progress had been made by the company, the connections having increased from an equivalent of 16,910 to 22,170 8-c.p. lamps. The result of the year's trading, including a balance brought forward of £224 18s. 11d., showed a profit of £2,279 14s. 9d., and after paying interest on debentures and loans, amounting to £1,399 19s., and writing off £55 18s. preliminary expenses, there was a surplus of £823 17s. 9d. The directors recommended the payment of a dividend at the rate of 4 per cent. for the year, and that £200 be placed to the reserve fund for renewal of plant, leaving a balance of £33 4s. 5d. to be carried forward.

The CHAIRMAN said that during the year £7,218 had been expended on capital, making a total of £57,142. The average number of lamps per consumer had decreased from 64 to 58. This was mostly due to the number of small workmen's dwellings now connected to the mains. During the year 21 new motors had been added, making an increase for the year of 37½ H.P. Owing to the reduction which took place at the beginning of the year in the charges for electricity, the annual revenue per lamp had gone down from 4s. 4d. to 3s. 10d., a very satisfactory state of affairs for the consumers, the number of units consumed per lamp being the same (13·4) in each case. The average price obtained was 3·64d. per unit, being ·33d. per unit less than that obtained last year. The machinery now installed, and in working condition, is capable of supplying 20,000 8-c.p. lamps alight at one time. The maximum demand made on the machinery during the last year was equal to an equivalent of 10,000 8-c.p. lamps. The result of the next year's working will be much more satisfactory. The directors are increasing the plant at the station to a considerable extent, by adding another battery and condensing plant, which will reduce the cost of coal per unit, and other working expenses.

The next business was to consider a resolution authorising the amount of the debenture issue to be increased to £30,000.

Mr. GRIPPER explained that they were authorised to issue £50,000 ordinary share capital, and the amount taken up was £15,100. They had also issued £15,000 in debentures, all held by Edmundson's Electricity Corporation. The form in which the debentures were drawn did not admit of that issue being increased beyond £20,000. What the directors suggested was that the meeting should authorise the debenture issue to be increased to £30,000. The present holders were prepared to waive their first charge and to allow their present debentures to rank *pari passu*, and also to make a stipulation that any further debentures which might be issued, so long as they did not exceed the share capital, also to run *pari passu*. In 20 companies with which he was connected they carried out the principle that the debenture issue should be as nearly as possible equal to the share capital. £15,000 debentures had been taken up, and what was suggested now was that they should offer the remaining £15,000—or, rather, £14,900—in shares, making the share capital £30,000, and also £15,000 more debentures, so as to make their debenture issue £30,000. They would thus have £30,000 for each. They would also get rid of the item in the account stated as owing to sundry creditors. He did not think they would get anything like that taken up by the shareholders. They would be offered to the shareholders first, and Messrs. Edmundson's were prepared to take up what were left. Otherwise they would only be issued to the shareholders.

The motion was carried.

Imperial Tramways Company.

THE ordinary general meeting of this company was held at Bristol on 26th ult., Mr. George White, presiding.

The CHAIRMAN, in moving the adoption of the report, said that there had been progress in every direction. As to the Middlesborough, Stockton and Thornaby tramways, the receipts and number of passengers carried showed an increase, the figures being £48,772 and 9,141,185, as compared with £47,228 and 8,782,970. The extension to Clarence Ferry was opened in August, and the additional accommodation had been much appreciated. The London United Tramways, Limited, had made great strides during the year. The traffic returns showed each week an ever-increasing volume of traffic, and when the extension of the system was opened to Twickenham, Richmond, Hampton Court, Kingston-on-Thames, Surbiton and other well-known London resorts, he believed that the anticipations of the directors which had already been published would be more than fulfilled. In connection with the sale of the London United undertaking to their new company, they, the Imperial Company, in respect of their holding of 29,000 6 per cent. preference shares in the old company, received 34,800 5 per cent. preference shares, which was the equivalent capitalisation, and represented an issue of shares to the full amount of the cost to their company of the old 6 per cent. shares. These 5 per cent. preferences were quoted in the market at £1 premium, and, therefore, they showed thus already a profit of nearly £35,000, which, however, they had not taken into account. In respect of the 6,000 old ordinary shares, they would receive a sum in cash estimated at £58,000 and 12,000 ordinary shares of the new company, so that after allowing for reinstating in their capital account, the full cost at which these investments stood in their books, there would remain over 10,600 of the ordinary shares coming from the new company, and these represented the profit on the transaction and belonged to the ordinary shareholders whether distributed amongst them or not. They believed the desire on the part of their shareholders to have a personal holding in the ordinary share capital of the London United was universal, and they had, therefore, determined that 5,000 of these profit shares should be distributed amongst the Imperial ordinary shareholders without calling upon them for any payment in respect of the shares. The shares would be allotted to the Imperial ordinary shareholders fully paid, and the allotment would run out to one new London United ordinary share for every four Imperial ordinary now held, and in order that every shareholder might be treated with fairness, they would issue fractions, so that every Imperial share would get its due allotment. When the new London United Company was brought out some ordinary capital was reserved for future issue, and it had been arranged that the Imperial Company should be permitted to at once subscribe at par for their due proportion of those unissued shares. That would run to 4,500 shares, and, therefore, they would see that the Imperial Company would still retain in its possession 11,500 London United ordinary which would yield such a return as to put it beyond question that the Imperial Company would in future be able to pay a minimum dividend of 10 per cent. on its ordinary shares, with the prospect, within a reasonable time, of either a permanent increase in that rate of dividend or some further substantial bonus, or possibly both. The net revenue account showed an available balance of £43,846 2s. 6d., and they were in a position to recommend a final dividend of 11½ per cent. per annum, making 10 per cent. for the year, on the ordinary capital, to add £1,000 to the dividends equalisation funds and to carry forward to the next account the remaining sum of £271 18s. 11d. They were also able to state that the various reserve funds were increased from £72,789 to £92,470, a feature which could not but add to the strength of the company.

Mr. J. CLIFTON ROBINSON seconded the motion.

Brush Electrical Engineering Company.

THE directors' report to be presented at the annual general meeting at Winchester House, E.C., on Thursday, April 10th, at 12 o'clock noon, reads as follows:—

"The directors beg to submit their report and the statement of accounts for the year ended December 31st, 1901.

"*Re-Constitution of Board.*—During the past year several changes have occurred in the constitution of the board. Mr. E. A. Hopkins and Mr. Reginald Ryley retired at the last annual general meeting, and Lord Vaux of Harrowden and Mr. C. Shirreff B. Hilton were re-elected directors in their place. Mr. Reginald Ryley was subsequently elected as a director to fill the vacancy caused by the regretted death of Mr. J. Slater Lewis, but, unfortunately, he succumbed shortly afterwards to an illness contracted abroad. In November last Mr. J. B. Braithwaite, jun., as foreshadowed by him in his speech at the last annual general meeting, resigned his position as chairman and director of the company. Lord Vaux of

resulting in the receipt of £2,282. £25 remains in arrears. 49,993 ordinary shares are considered as fully paid. Mortgages and charges, £9,200.

"rates" on property. Taking wages and repairs together the drop

Harrowden has recently accepted the chairmanship of the company, and Mr. G. F. M. Cornwallis-West and Mr. W. L. Madgen have lately been elected as directors to fill casual vacancies on the board. The retiring directors are Mr. J. S. Raworth and Mr. G. F. M. Cornwallis-West, who, being eligible, offer themselves for re-election.

"*Profit and Loss Account.*—The profit and loss account shows a gross profit of £61,054 8s. 2d. After deducting general charges, maintenance, interest on debenture stock, bonus to employés under the profit sharing scheme, and amount placed to depreciation and general reserve funds, there remains a balance of net profit of £7,455 8s. 11d. Of this sum £7,088 17s. 6d. has been applied to the payment of the dividend on the preference shares at the rate of 6 per cent. per annum for the half-year ended June 30th last, leaving the balance of £366 11s. 5d. to be carried forward to next account. The net profits would have been larger but for the fact that the directors have deemed it necessary to debit profit and loss account with the sum of £8,500 placed to a general reserve fund. Under Article 117, Sub-sec. 21, of the company's articles of association, this reserve fund is available to meet contingencies, for equalising dividends, or for repairing, improving, and maintaining any of the property of the company, and might be applied in payment of part of the preference dividend for the second half of the year 1901, but the directors are of opinion that it would not be prudent to do so. The auditors refer in their report to the patents and goodwill account, and to certain of the company's investments. These matters, and the position generally, are receiving the careful consideration of the directors, but the board having only lately been reconstituted cannot at present make any recommendation. The directors are confident that the economies and reforms which they are carrying out will produce improved results in the future.

"*Capital Account.*—The share capital account has been increased during the year by £76,491, the proceeds of the issue of the remainder of the preference shares of the company, and, in addition the sum of £30,740 has been received from the British Electric Traction Company, Limited as an advance in respect of an undertaking they have entered into to take up 25,000 of the £2 ordinary shares of the company at par. A liability of £6,793 13s. 8d. has been incurred in connection with these issues, of which £2,593 13s. 8d. has been charged to the profit and loss account for the year. Capital expenditure to the extent of £15,536 13s. 8d. has been incurred during the year on new plant and buildings. The remainder of the new capital has been applied to the discharge and reduction of the obligations and liabilities of the company.

"*Auditors.*—Messrs. Cooper Brothers and Co., the auditors, retire, and offer themselves for re-election."

Salisbury Electric Light Company.

The annual meeting of this company was held at Salisbury some days ago, Mr. W. M. Hammick presiding.

The Chairman, in moving the adoption of the report, said that they were continually buying plant, and the company was advancing very satisfactorily. They had done very good business during the year, and the amount taken, £2,731 1s. 10d. for current supply did not really compare with the £2,320 shown in last year's balance-sheet. It did not show the actual increase of work, for they had altered their system of charging consumers, and it made a difference in favour of the consumer of £300. The company was purchasing new machinery in order to meet the increased demands contemplated. They had entered into a contract to light the new station at Salisbury. The contract would amount to something like £3,400. There would be no less than 90 arc lamps on the station premises. The Free Wiring Company had done work in the town, but they had now retired, and their company had taken up free wiring, which had proved to be a profitable addition to their business, although it required a little more capital. There had been a steady advance in the work, and the directors had pleasure in recommending a dividend of 4 per cent. on the ordinary share capital of the company.

Mr. Edmundson seconded the adoption of the report.

South London Electric Supply Corporation.

The directors' report for the year ending December 31st, 1901, to be presented at the meeting to be held at the offices, Bengeworth Road, S.E., on April 8th, reads as follows:—"The revenue account shows a credit balance of £1,691 8s. 11d., as against a loss of £889 14s. 3d. in the previous year. On December 31st, 1900, current was being supplied to the equivalent of 43,322 lamps of 8-c.p. On December 31st, 1901, this number had increased to 56,510. At the present time there are on circuit the equivalent of 59,663 lamps of 8-c.p., and applications are to hand for a further 1,385 lamps. It will be observed that there is a slight falling off in the units sold to consumers when compared with last year. This is due to the fact that in 1900, during the reconstruction of works by a neighbouring supply company, there were sold to them no less than 330,753 units which realised £3,719 18s. 4d. The length of roadway in which mains have been laid is now 49 miles of high-tension and 42 miles low-tension ways, in which 33½ miles of high-tension and 42 miles of low-tension cable have been laid. The high price of coal in the first half of the year has again considerably affected the net revenue, and the great increase in rates and taxes, and costs incurred in obtaining an equitable assessment, have materially decreased the profit balance. The original assessment was £5,667 rateable value, which has now been reduced to £3,000. During 1901, economisers and condensing plant were erected, and although these were not completed until the end of the year, the directors are pleased to report that already a considerable decrease is evident in the consumption of coal. Had this plant been in operation at the time contracted for, a further decrease in the cost of coal would have been shown. It will doubtless be a source of much satisfaction to note the substantial decrease in the costs of generating and distributing the current. These, which last year were 3·65d. per B. of T. unit sold, are this year 2·95d. The plant and mains have been maintained in a very high state of efficiency, and so soon as the load is commensurate with the size of the station, the directors feel sure that the economy of the working costs will be more clearly apparent. The action brought by the Lambeth Borough Council against this Corporation in respect of the stoppage of the dust destructor came before Mr. Justice Wright on March 12th. After hearing the plaintiff's case, the judge suggested the desirability of an amicable settlement being arrived at, and offered to adjourn the case for this purpose. As the directors have throughout been desirous of such a result, they welcomed the suggestion, and an adjournment for four weeks was accordingly arranged. The directors are now waiting to hear what proposals the Lambeth Council have to make in pursuance of the Judge's expressed opinion. The board have pleasure in reporting that a favourable agreement has been entered into with the London County Council. By this agreement the corporation will supply steam to drive machinery of 5,000 h.p. about to be erected at the sole expense of the Council on the property of this corporation for operating the municipal tramways. This will utilise the existing boiler plant for some time to come, thus tending to reduce generating costs, and at the same time providing a beneficial revenue during the currency of the agreement. In accordance with the articles of association two of the directors, W. W. Phipps, Esq., and Algernon Turnor, Esq., C.B., retire, but being eligible, offer themselves for re-election. The auditors, Messrs. Price, Waterhouse & Co., also retire, and they being eligible, offer themselves for re-election."

The Lymington Electric Light and Power Company.

The report of the first year's working is to the effect that the balance of net revenue is £379 2s. 7d., of which it is proposed to apply £112 to the payment of a dividend of 4 per cent. for the year, carrying forward the balance. In arriving at this balance it is pointed out that during the year no interest has been paid upon the local capital provided by Messrs. Edmundson. The number of lamps connected to the mains at the beginning of last year were equivalent to 1,705 8-c.p. lamps, and this number was increased to 4,557 at the end of last year, with 152 consumers connected to the mains.

Willans & Robinson, Limited.

Mr. Mark Robinson (chairman) presided on Wednesday last week over the ordinary general meeting of the above company, held at Cannon Street Hotel, and, in moving the adoption of the report, said he might fairly express the satisfaction of the board with the results which had been attained in their present transition state. They showed larger profits than ever before, and though the unavoidable burden of capital, which as yet earned nothing for itself, precluded them from repeating the bonus of the last two years, yet they kept up a rate of dividend which at one time they felt very proud to declare. The Rugby extensions were coming into beneficial use, though there was much still to do, and the progress of everything had suffered from the almost unaccountable delays of the crane makers and tool makers generally. Still they were on the point of beginning to realise the lessened cost of work which the extensions had been designed to secure, and to benefit by the better appliances which they would soon command for dealing with altogether bigger work. At Queensferry the boiler works had made good progress, though much less rapid than they hoped. Steel had been manufactured at intervals upon a commercial scale, sufficiently to prove to them that they could make steel of excellent quality for their purposes. The making of really good steel complying with the specification one desired to work to was not by any means a matter of course, and it was a real cause for congratulation that on their first trial, so to say, but with the corroboration of later trials as well, they had entirely realised these wishes, and more than realised their expectations. Queensferry was a success in one point. They wanted good steel from it, and they had got it. On the table was an example from the very first ingot cast. The knot was tightened in it by two locomotives pulling in opposite directions, and it did not require great expert knowledge to see how admirably the steel had stood this severe handling, a judgment confirmed by more scientific tests carried out afterwards. Subsequent casts had satisfied them that this good beginning could be kept up and maintained, and that scientific and well organised work would bring its reward in this, as in other departments. It was not less important to them that inquiries for their steel were coming forward from users who wished to buy from them, and that it seemed to be assumed that what they made would be something specially good; they meant to try to keep up this character. The superintendent of the tube shop expected to begin drawing tubes in July, and they saw no reason why they should not be erecting boilers before the end of the year. They were sometimes asked if, with their later experience, they felt satisfied with the works and with the plant at Queensferry. They could only answer that, so far as their knowledge went, they believed they had there, upon the whole, the finest boiler-making plant in the kingdom. There would doubtless be corrections to make—they had found them necessary in the steel

plant—but, on the whole, and in the absence of the final test of use, they were more than satisfied with what had been done, and more than one foreign visitor had paid eloquent tribute to the planning and equipment of the works. But they had learnt one lesson as the work had proceeded, or, rather, they had learnt it afresh at every stage, with cumulative effect. It was, that modern industry, to be a success, must be on the large scale. "Just a little shop, to make so-and-so for ourselves," was not a wise ideal for modern works, though he must confess that it was in some degree their ideal when they started. The inevitable development had led to a great increase of expenditure beyond the original estimates, but he thought it would prove to be fully justified. At Rugby, as they knew, they had had to extend even their extensions, and though they thought that, apart from mere roundings-off, that process was over for a time at Rugby, where they were really big enough, it was not over at Queensferry, where, even for the start, they should do much better with a larger foundry, and probably, though they had not quite decided that point, with an additional steel furnace. At present they had only one. With these views they had asked permission to increase the debenture debt from £100,000 to £250,000. A week ago their finance stood thus:—Orders had been given, or in principle approved, for buildings, plant, &c., upon which there would be to pay, when the work was done, a further sum of £92,733 beyond payments already made. Against this there was money on deposit, or otherwise, but, of course, not counting the reserves, and not counting cash actually in hand for current needs, amounting to £48,516, so they had already a potential need for £44,217. Beyond this, they required money for further plant at Queensferry, and for some at Rugby, not yet decided upon. They must have a margin to enable improvements to be made, if they should afterwards be found desirable, and they must have working capital for the new business, as well as for the old business, and further, as past experience taught them, they must provide a large margin under this head for the tendency to an increased lock-up in stock and in book debts, which a growing business entailed. For all these services £150,000 additional was not too much, and they will be asked to sanction this increase of borrowing powers. Sir Gilbert East would tell them that they hoped to obtain the sanction of the present debenture stock holders to the new arrangement, and not only their sanction, but their willing co-operation. It was worth while to point out that when the existing issue of £100,000 was made, the net assets of the company, after deducting debts, amounted to £204,100, excluding goodwill. Now, to secure the proposed issue of £250,000, they had on December 31st last (and they had more now) net assets of £938,868, or over four and a half times as much, to secure a debt only two and a half times as great. The present assets included neither goodwill nor patents, for goodwill and patents had both been written off completely. It would be seen that £16,355 still remained to the credit of the premiums on shares account. Against this they would propose to set the expenses of the new debenture issue, if sanctioned, and the balance they proposed to hold as a kind of fund against which they might from time to time charge any very exceptional expense, such as exhibition expenses, removal expenses, and the like, which had been the subject of consideration before. There was a charge which could be so treated, on account of their exhibit at the Glasgow Exhibition—an exhibit which proved beneficial to them. They proposed also to exhibit, but on a smaller scale, at the Wolverhampton Exhibition this year, and perhaps in one which was announced for 1903 in Japan. The move from Thames Ditton was on the point of completion, and that would involve expenses exceeding the amount at present reserved. Of matters of minor interest, in view of the larger subjects which required consideration, he thought it was only necessary to refer to the Works Volunteer Corps. It had been a very marked success, and the men had entered into it most heartily.

Mr. Anderson seconded the motion for the adoption of the report.

Replying to a number of questions asked by shareholders, that the debtors stood at £145,000, and in many cases they were contra accounts. At the end of the half-year £52,000 was owing on account of invoices sent out during the last fortnight of the year, and £78,000 had been sent out in the course of October and November, so that it would be seen that the amounts of any long standing were very small. The largest debtors were the Corporation of Liverpool. Of the whole of the sums owing, £46,000 was owing directly by municipalities, and £54,000 by dynamo-makers on account of engines supplied to municipalities. The £145,000 really did not represent what was owing to them, but only their value after everything possible had been written down. With regard to the smaller amount of work in progress at the end of the year, as shown in the accounts, that was simply due to the fact that they were able to send out invoices for a great number of engines, which were furnished, but it might just as likely have happened that they were carried over January 1st. The large amount of cash at the bank was due to the final payment on the shares. With regard to the works at Queensferry, they hoped to have the whole of the works at work in a few months' time. They would put off the issue of further ordinary share capital as long as possible. They were prepared to give an indication in the report of the relative earnings of the boiler works and the other portions of the business, but they would like a little freedom in the matter. It was intended to dispose of the works at Thames Ditton as soon as possible. They had standardised engines up to 6,000 H.P., and on several occasions they had tendered for such engines when people had talked of having a larger number of units in the station.

The report was adopted, as well as a resolution recommending the payment of a final dividend of 6 per cent., making 10 per cent. for the year.

The chairman and Sir G. Clayton East were re-elected directors.

The meeting was subsequently made special for passing a resolution authorising the board to issue £250,000 debenture stock.

Bournemouth and Poole Electricity Supply Company.

The fifth ordinary general meeting of the proprietors of this company was held on Tuesday last week at the offices, Moorgate Court, Moorgate Street, E.C., Mr. A. H. Sanderson presiding.

The Chairman, in moving the adoption of the report, said he thought they would all agree that the accounts presented were satisfactory. With regard to the assets of the company of capital appropriated to the Bournemouth Provisional Order (1890) and the Poole and Branksome Order (1897), which amounted to £195,818, of that sum £26,246 had been spent during the past year. They would perhaps at first sight consider that amount to be rather large; but he could confidently assure them that the whole of that capital had been well spent, and had been necessary for the lighting station at Bournemouth Valley, which had been enlarged, and would shortly be in use. Additional machinery had also been installed, and a considerable amount of money had been spent on mains in Bournemouth, and new districts had been opened both in Poole and Parkstone and in the suburb of Winton. He wished to point out that the directors regretted that large expenditure on the mains, but it was of vital importance to the company's business, and the money which had been spent would be productive of revenue, and would result in increased dividends to the shareholders. The item of sundry debtors remained practically the same as last year, and represented more particularly the amounts due from consumers, a very large proportion of which had been collected. On the liabilities side of the account, the first item that required any recognition was the sum of £51,700 of loans against security, which they would observe had increased from £16,950 in 1900, and represented loans from the company's bankers. The past year, as they all knew, had not been favourable for issuing further capital, and the directors had therefore found it more economical to borrow money from their bankers at a very low rate instead of making a further issue of shares. The reserve from premiums, it would be noticed, had been reduced by £515, which had been written off in respect of preliminary expenses. The depreciation account had been increased from £3,704 to £5,304, £2,000 having been placed to the credit of this item out of revenue during the year, and £400 had been written off, which left it at £5,304. Before leaving that side of the accounts, he would draw their attention to the fact that their authorised capital stood at £300,000. Previous to that year it had only amounted to £150,000, but in accordance with the resolution passed on July 18th last, they had increased their capital by the creation of 7,500 new ordinary shares of £10, and 7,500 preference shares at £10 each. Turning to the revenue account, he said he was sure they would agree that the total gross receipts of £22,618 formed a most satisfactory feature. In 1900 they amounted to £17,504, showing an increase last year of £5,114, which was equal to 30 per cent. That increase was mainly attributable to the sale of energy, and he trusted that item would continue to increase year by year. There was an increase in the revenue charges, but that was only to be expected, owing to the large sale of energy. The balance remaining for distribution amounted to £8,918. The dividend on the preference shares had been paid, and a dividend of 7 per cent. on the ordinary shares was now recommended, which payment would absorb £8,140, leaving £778 to be carried forward. Referring to the business of the company generally, they would observe that applications from intending consumers within the company's area were encouraging. The connections during the past year with their mains showed an increase of 12,583 8-c.p. lamps, which compared very favourably with the increased number of 9,283 8-c.p. lamps in 1900. Since January 1st of the current year, the applications for current had been numerous, and had more than exceeded the number of applications which were received during the same period last year. Last year they completed the contract with the Poole and District Electric Traction Company for the supply of current for the tramways running between Bournemouth and Poole, and he would also inform them that satisfactory arrangements had been made for working the tramways on the east of Bournemouth. The Poole tramways had been running since the spring of last year. Considerable sums of money had been spent on the new districts; the supply of current was now available there, and the demands were increasing very satisfactorily. He looked forward to the result of the present year's working with satisfaction, and thought they would be able to come before them next year with a report and balance-sheet that would give entire satisfaction. With regard to the Richmond Company, he was pleased to say that it continued to make satisfactory progress, the number of lamps having slightly increased. That company had paid a dividend of 6 per cent. on its ordinary shares as against 5 per cent. last year, and he thought they ought to feel satisfied that they possessed there a sound and improving investment. There was one matter he wished to particularly draw their attention to, which was, that both the directors and staff of the company had experienced considerable trouble and expense through the attitude the Bournemouth Corporation had adopted towards the company. For many years past they had been subjected to the same obstruction, and the development of their business had been retarded, but it had been far more acute since the Corporation had come to the conclusion that the company was going to be a prosperous one, and they had thought it desirable for them to acquire it. He only made those remarks to them in general terms, but if it became necessary at any time it would not be at all difficult to particularise. During the last few weeks the Corporation had been obstructive in the

ss-essment, have materially decreased the profit balance. The original assessment was £5,667 rateable value, which has now been reduced to £3,000. During 1901, economisers and condensing plant went, they believed they had there, upon the whole, the finest boiler-making plant in the kingdom. There would doubtless be corrections to make—they had found them necessary in the steel

general working of the company, and several notices and plans had been opposed without any special reason, and at the present time the company had two appeals before the Board of Trade for settlement. In times past they had only to give three days' notice of any ordinary connection, but he believed now the surveyor had insisted upon a monthly notice, and he need not point out to them that it would be very detrimental to the business of the company if a consumer had to wait that length of time. He ventured to state that if the Corporation had adopted more conciliatory terms towards them, the company would have reached the progressive part at an earlier stage. That state of things he thought was not conducive to the interests of the residents at Bournemouth, for the fact of that obstruction had very much postponed the period at which the company hoped to be able to reduce the price of their current.

Mr. J. Atkinson Hosker seconded the motion, and the report was adopted.

Potteries Electric Traction Company.

The fourth ordinary general meeting of the shareholders of this company was held on Tuesday last week at Hamilton House, Victoria Embankment, Mr. Emile Garcke in the chair.

The Chairman, in proposing the adoption of the report, said that the accounts for the past year showed an advance and improvement in almost every direction. The few respects in which the position appeared to have deteriorated were entirely beyond the control of the directors, but wherever the results had been capable of being improved by energy or close attention to detail, he was glad to say that, thanks to the managers and to the support which they had received all round, they had been able to effect improvements. They were running at present something like 29 miles instead of 23 miles this time last year, and they had carried during the past year over 13¼ million passengers as against something under 10 millions. The gross receipts from traffic had gone up from £53,290 to £73,590, showing an increase of something like £20,000. Other items of receipts also showed improvements. The expenses, he was glad to say, also showed a very material reduction, though, unfortunately, owing to one or two items which had abnormally increased, the aggregate expenses did not reflect the reductions which had been effected, and the percentage of expenses to receipts, curiously enough, was exactly the same as last year, although the volume of business done was very much larger. In almost every respect the expenditure had been reduced, but there had been an increase in the items of local rates and third party assurance. The general expenses of administration appeared at the figure of £5,009 as against £4,769, showing an increase of about £240, but the rates and insurance alone had increased by over £900, which had more than neutralised all the savings they had been able to effect in the various other directions of expenditure. Those two items were of course entirely beyond the control of the directors. They were sometimes told that local rates tended to diminish by reason of municipal trading and similar causes, but although the rate per £ might not go up, the amount of rates that companies like themselves had to pay very frequently, increased by reason of increased assessments. The item of repairs and maintenance also showed an increase. They had spent £6,597 as against £4,762 in the preceding year, but that was not really an increase, when they considered the fact that they were running six more miles than last year, and they also had additional power houses and car shops, and altogether were doing a much larger volume of business. He need only repeat what he said on the last occasion that the lines and the various properties of the company were kept in a high state of efficiency at the expense of the revenue for the year. That was a policy which the shareholders had already approved, and he trusted as time went on they would see the wisdom of having approved it, so the money they proposed to place to depreciation and reserve might in the course of time prove to be a real nest-egg for any shortcomings on capital account, or to meet any calamity that might befall the company. There was a certain guarantee in working an electrical tramway that the lines were kept in a high state of efficiency, because the lines could not be worked economically if they did not do so, and they would see that the percentage of expenses to receipts was no higher than it was last year. If they could continue the efforts that they were making to still further reduce the expenditure, and they did not meet with any unexpected calls in the way of increased rates, he hoped that the percentage of expenditure to receipts might be still lower. There were one or two reasons why the results of last year had not been better, the chief of which was the great depression that had existed in the Pottery districts, and he was afraid that state of things was likely to last for some time. Against that they had the very important feature that the electrical tramway industry was always a progressive one. At the present time they were carrying the population of the Potteries something like 40 times per annum, and their estimates were based on carrying them at least 50 times per annum, so that as yet they had not succeeded in tapping the whole of the business which they were fully confident from their experience in other parts of the country was capable of being done. So far they had been handicapped by only being able to run single-deck cars, but on the new lines, which would shortly be opened, they would be able to run double-deck cars. On the whole, the board were satisfied with the results achieved during the past year, and they trusted that they would be able to submit a better report in respect of the present year's operations. During the year they had issued 2,000 additional ordinary shares and 2,000 additional preference shares, but so far they had only called up £1 per share, so that they had a large balance of unissued capital. A further £75,000 of debentures was issued to the British Electric Traction Company. The new capital had been spent in the construction of the additional lines, and on the erection of additional plant and power houses, and they had also put down additional feeders for the more economical distribution of current. They had also obtained 27 additional cars, 25 of which were double-decked cars capable of carrying about 40 passengers each, so that the whole of the equipment of the company was in a very complete condition. They had been pressed by the local authorities to make many further extensions in the outlying districts, but the directors had thought it wise to defer the development of any further lines until the existing capital was fully remunerative. In conclusion, the chairman referred to the establishment of an express parcels delivery service in connection with the tramways, which he said was started shortly before last Christmas, and which so far had answered their expectations.

Mr. C. F. M. Cornwallis-West seconded the motion.

Replying to a question, the Chairman said the company had made much more favourable coal contracts for the current year.

The report was adopted.

English Electric Manufacturing Company.

The general meeting of this company was held at the company's offices, Strand Road, Preston, on 19th ult. Mr. R. H. Prestwich presided.

The Chairman, in moving the adoption of the report, and the annual statement of accounts, said the gross profits amounted to no less than £69,407 12s., and after liberal provision had been made for depreciation, and deductions for debenture interest, dividend on preference shares, preliminary expenses, &c., there was a balance left of £27,479 16s. 5d. The amount of profit covered a period of 18 months. Continuing, the chairman said that the first six months' operations of the company naturally did not result in any profit to the concern. The works were now fully equipped, and the productions of the company were despatched to almost every country. Having referred to the unfortunate illness of the managing director, Mr. Flett, who, he said, was now happily recovering, the chairman stated that the directors had decided to carry over the large balance of £27,479 16s. 5d., which was sufficient to pay 13 per cent. on the ordinary shares, because they wished to make the concern as sound as possible.

The report was adopted, the auditors re-elected, and, in response to a vote of thanks proposed by Sir William Mitchell-Thompson,

The Chairman stated that the prospects for the ensuing year were of the brightest character. He further alluded to the success of the company in securing the London County Council's order.

Dover Electricity Supply Company.

Sir William Crundall presided over the annual meeting of this company on Wednesday last week, and in moving the adoption of the report, which has already appeared in our columns, said that for this year he had no hesitation in saying that they would pay a minimum dividend of 7½ per cent. They had made a very favourable coal contract for the year which in itself gave more than 1 per cent. dividend—the difference between the price of coal this year and last. Economies and improvements had also been made in working the plant. He referred at some length to the proposal of the Corporation to purchase the undertaking at £8 10s. per £5 share, and he gave his reasons for thinking it best in the interests of the ratepayers that the purchase should be effected. The report was adopted.

Bromley (Kent) Electric Light and Power Company.

The directors' report to December 31st last says:—

The progress made by the company during the year has been satisfactory, the lamp connections in Bromley having increased from 13,395 to 20,125, whilst 6,691 are being supplied in Chislehurst. Applications for 2,000 additional lamps have already been received this year. The sale of current has increased from £4,044 to £5,756. The result of the year's trading, including the balance £122 7s. 10d. brought forward from last year, shows a profit of £3,461 0s. 5d., and after payment of debenture, and loan interest amounting to £2,525 2s. 2d., the amount available for dividend is £935 18s. 3d. The directors recommend the payment of a dividend at the rate of 4½ per cent. for the year, and that £400 be placed to a reserve fund for a renewal of plant, leaving a balance of £65 8s. 5d. to be carried forward to the next account. Extensions to the plant, which have been completed during the year, have enabled considerable economy to be effected in the working of the station. It is proposed to submit a resolution authorising the directors to acquire an interest in the Chislehurst Electric Supply Company, Limited, by subscribing for the whole or part of the share capital of that company; also a resolution authorising an increase of the debenture issue to £50,000; also a resolution to increase the number of directors to six, by the appointment of Mr. Edmund Charrington and Mr. John Cuthbert Wigham. One of the directors, Mr. Daniel Grinsted, retires by rotation, and being eligible, offers himself for re-election.

The annual meeting was recently held at the Bell Hotel. The chairman, Mr. Gripper, in moving the adoption of the report, said that on the year's working they had increased their revenue by £1,700, whilst they had made a profit of £171 on the wiring account. The balance carried to net revenue account was £3,167, as against £1,812 last year. This extra amount of revenue had not been obtained by charging their customers more for their supply (as the same price was obtained now as in previous years), but by increasing their business. In 1900 the total number of units sold amounted to 209,000, whilst last year it was 306,000, and to obtain this additional output only £100 of coal extra had been used. The total cost per unit in 1900 was 2·72d., and in 1901 it had been reduced to 2·2d., or a reduction of just over ½d. a unit. These prices were due to the economical working of the station by the engineer. The accounts

showed that the profit on the year was £3,338, as against £2,009 last year—an increase of £1,300. A dividend of 4½ per cent. for the year was declared, £400 being placed to reserve for plant renewals. Resolutions were submitted to the meeting and passed authorising the directors to acquire an interest in the Chislehurst Electric Supply Company by subscribing for the whole or part of its share capital, and authorising an increase of the debenture issue to £50,000.

City and South London Railway Company.—A special general meeting was held on 25th ult. at the offices, Finsbury Pavement, Mr. C. G. Mott presiding, and resolutions were passed approving the Bill now pending in Parliament for incorporating the Islington and Euston Railway Company; the insertion of an additional provision in the Bill on petition substituting the company for the proposed Islington and Euston Railway Company, and authorising the City and South London Railway Company to carry out the works and exercise the powers contained in the Bill; and the provisions of a working agreement proposed to be entered into between the two companies were also passed.

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to:—Notting Hill Electric Lighting Company, Limited.—Further issue of 2,200 ordinary shares of £10 each, fully paid, Nos. 12,201 to 14,400. Application has also been made to the Committee to allow the following securities to be quoted in the Official List:—Brisbane Electric Tramways Investment Company, Limited.—£400,000 4½ per cent. first debenture stock (redeemable), in lieu of the provisional certificates now quoted. Notting Hill Electric Lighting Company, Limited.—£50,000 4 per cent. first mortgage debentures of £100 each, Nos. 1 to 500 (registered). Willans & Robinson, Limited.—Further issue of 26,666 ordinary shares of £5 each, fully paid, Nos. 90,001 to 116,666; and 16,666 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 125,001 to 141,666.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramways.—The receipts for the week ending March 29th were £415; corresponding week last year, £147; increase, £268. Total receipts to date, £2,351; corresponding period last year, £1,883; increase, £468.

Bristol Tramways and Carriage Company.—The receipts for the week ending March 28th were £4,210; corresponding period last year £3,581; increase, £629.

Central London Railway.—The receipts for the week ending March 29th were £6,121; corresponding week last year, £6,228; decrease, £107. Total receipts to date, £85,840; corresponding period last year, £79,235; increase, £6,605. Miles open, 6.

City and South London Railway.—The receipts for the week ending Mar. 30th were £2,655; corresponding week last year, £2,122; increase, £533. Total receipts to date (13 weeks), £28,941; corresponding period last year, £26,437; increase, £12,504. Miles open, 6½; last year, 4½.

British Electric Traction Company.—The following returns are issued of the undertakings of this company for the week ending March 21st:—

Company.	Amount £	Comparison with corresponding week of last year. + £	Comparison with corresponding week of last year. — £	No. of weeks.	Aggregate. Amount. £	Aggregate. Inc. or Dec. + £	Aggregate. Inc. or Dec. — £
Devonport *	343	—	—	11½	4,348	—	—
Dudley—Stourbridge	674	170	—	11½	6,960	1,315	—
Gateshead *	667	—	—	11½	7,067	—	—
Greenock-Pt. Glasgow	449	274	—	11½	4,132	2,202	—
Hartlepool	181	5	—	11½	1,904	—	26
Kidderminster ..	105	20	—	11½	1,021	101	—
Merthyr *	192	—	—	11½	2,121	—	—
Oldham—Ashton ..	486	29	—	11½	5,121	—	24
Poole *	217	—	—	11½	2,042	—	—
Potteries	1,430	146	—	11½	15,258	512	—
Southport	156	54	—	11½	1,426	248	—
South Staffordshire†	786	118	—	11½	8,015	449	—
Swansea	447	43	—	11½	4,490	370	—
Taunton *	55	—	—	11½	583	—	—
Tynemouth ‡	200	10	—	11½	2,039	10	—
Wolverhampton Dist.	141	93	—	11½	1,383	872	—

* Not in operation last year. † Partly steam.
‡ Comparison from March 18th only.

Dover Corporation Tramways.—The receipts for the week ending March 28th were £234 4s. 8d.; corresponding week last year, £153 7s. 3d.; increase, £80 17s. 5d. Total to date, £2,185 1s. 0½d.; corresponding period last year, £1,998 5s. 0½d.; increase, £186 16s. 0d. Miles of track open, 8. Car miles run, 1902, 5,296; 1901, 5,114. Number of cars, 1902, 12; 1901, 11.

Dublin United Tramways Company.—The receipts for the week ending March 28th were as follows:—D.U.T. Co., £3,415 10s. 9d.; D.S.D. Co. £731 16s. 0d.; total, £4,147 6s. 9d.: corresponding week last year—D.U.T. Co., £2,929 3s. 5d.; D.S.D. Co., £620 10s. 0d.; total, £3,549 13s. 5d.; increase, £597 18s. 4d.; aggregate to date, £49,882 6s. 9d.; last year, £46,935 19s. 1d.; increase, £2,946 7s. 8d. Mileage worked 46.

Glasgow Tramways.—Week ending March 29th, 1902, £10,952 12s. 10d., compared with £7,999 3s. 11d. for the corresponding week last year. Since commencement of present financial year, June 1st, 1901, aggregate drawings are £508,042 5s. 7d., compared with £393,365 6s. 9d. for the same period in the previous year.

Liverpool Overhead Railway.—The receipts for the week ending March 30th were £1,418; corresponding week last year, £1,462; decrease, £44. Total to date £17,869; corresponding period last year, £19,206; decrease, £1,337. Miles open, 6 miles 67 chains.

STOCKS AND SHARES.

Wednesday Evening.

The Stock Exchange returned to work in light heart on Tuesday, quite ready to make the best of anything which might favour rising prices. At the outset it looked as though the House had really come back to business, but as soon as the morning's post orders had been executed, it became obvious that there would be very little else for the markets to do that day, and consequently many members retired early. Nor did to-day show much increase in the volume of trade, and the holiday air will hardly be disposed of until next week. The electrical supply section is fairly busy, but in the telegraph market there is very little going on, and the miscellaneous department, as a whole, is gently slumbering.

The Brush Electrical Engineering report is one of the most interesting, as it is also one of the most disappointing, items of the week. The sharp fall that has occurred in the price of the shares during the past fortnight is now fully explained, but that some people should have had knowledge of the position for so long before the body of shareholders, and acted upon that knowledge, constitutes a grave irregularity, to put it mildly. Possibly it is those favoured few who got out of their shares much higher up, a few weeks back, who are now repurchasing, and giving the market some appearance of strength. Business is being done at the middle price in both classes of shares. Careful consideration of the report—which shows that the company made a gross profit of only £600 less than in the corresponding part of last year—does not make it clear why the Preference shares (non-cumulative, be it noted) should have to forfeit their half-year's dividend, when this time a year ago they were paid in full, and the Ordinary received 5 per cent. That a reserve fund is necessary will be denied by no one, but when it comes to starting such a fund at the expense of holders of non-cumulative Preference shares, the matter assumes a complexion out of the common. Brush Preference proprietors have every reason to be disgusted with the report now presented.

Central London stocks are lifting up their heads again, and the Ordinary has risen 2 since we last wrote. The impression is that the fall, like January's rise, was overdone, and it is fairly pointed out by some that the line is not likely to earn less than its previous 4 per cent. in this the Coronation year. And of course a pretty safe 4 per cent. home railway stock at anything beneath 110 is not to be by any means despised. The Preferred stock has stuck steadily to 104½, and this security deserves more attention. It possesses all the necessary elements for a 5 point advance. Other electrical railway stocks display no change. Great Northern and City Preferred "A" are about 8½, while District and Metropolitan stand at 30 and 73½ respectively. That they do not do all things better in France is shown by the lately-published Paris Traction Company's balance-sheet, which shows a debit balance for the year of the enormous amount of 200 million francs, or, say, £800,000. This ghastly result is due largely to the fact that, having no experience to guide them, the company's directors agreed with the municipalities to charge fares which have proved ridiculously unremunerative. Our own London United Tramways Debenture stock is changing hands at 103, and in the last day or two there has been quite a smart rise in London Road Car shares upon the introduction of the company's new horseless omnibuses.

The telegraph market keeps firm, and how little it takes to influence prices may be illustrated by the rise of a point in Anglo-American Preferred at the appearance of a buyer for the relatively small amount of £2,000 stock. Direct Spanish, Western Telegraph and Direct United States shares, are all marked *ex* dividend, but the nominal prices remain as before. Commercial Cable stock, however, has fallen 85, although the dividend deduction is only $1\frac{3}{4}$. National Telephone issues are lifeless, but a fair amount is doing in Globe Telegraph and Trust shares of both orders, the cheapness of the prices attracting investors' attention. The Preference look a thoroughly sound lock-up, and there cannot be much risk in buying the Ordinary at £1 under par. Marconi shares fail to improve to any extent, despite the publication of the agreement arrived at between the company and the Canadian Government. The price is still 3¼.

The quoting of several more electricity supply shares *ex* dividend has produced little effect, Notting Hills being the only ones lowered. There is still a demand for Debenture issues, and small rises are scored by Charing Cross Debenture and City of London Second Debenture. The South London Company's report is out, but has given no fillip to the price of the shares. Chelseas are ¼ better.

In the Miscellaneous division, Henley's have shed ½, and thus dropped into line with Callender's again. Telegraph Manufacturing Preference are *ex* half-a-crown dividend, but keep at 5⅜, Babcock and Wilcox are a fraction harder at $3\frac{1}{16}$, and Willans & Robinson remain at 9¼. Castner-Kellner shares at ⅞, and the 4½ per cent. Debenture stock at 90 are about the same, while Castner Electrolytic Alkali (U.S.A.) 5 per cent. Debentures are 90½. Westinghouse Preference shares can be bought at $\frac{1}{16}$ under £6, and Electrolytic Alkali Ordinary shares are ⅞, the Preference commanding ⅛ more.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotation March 25th.	Closing Quotations April 2nd.	Business done during week ended April 2nd, 1902. Highest.	Lowest.
82,300	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	...	...	...	3½— 4½	3½— 4½	...	...
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	70 — 80	70 — 80	...	...
804,720	Anglo-American Telegraph	Stock	73/6	3⅛%	61s.	46 — 49	46 — 49	...	...
3,097,640	Do. do. 6 % Pref	Stock	6 %	6 %	6 %	89 — 91	90 — 92	91½	90½
3,097,640	Do. do. Deferred	Stock	£1 7s.	5s.%	2s.	7¼— 7⅜	7¼— 7⅜	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	5 %	...	3⅜— 4	3⅜— 4	...	...
13,333,300$	Commercial Cable	$100	8 %	...	...	155 —165	150 —160 xd	...	...
1,741,029£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	95 — 97	94 — 96 xd	...	...
16,000	Cuba Telegraph	10	7 %	...	...	4½— 5⅛	4½— 5⅛	...	...
6,000	Do. 10 % Pref.	10	...	...	...	13 — 14	13 — 14	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	3 — 4	3 — 4 xd	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	8½— 9½	8½— 9½	...	...
30,000£	Do. do. 4½ % Debs.	50	...	...	...	98 —102	98 —102	...	..
60,710£	Direct United States Cable	20	3½%	3½%	...	9½— 10½	9½— 10½xd	10	9⅝
101,300£	Direct West India Cable, 4½ % Reg. Deb., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	125 —135	125 —135	132	
1,930,807	Do. 3½ % Pref. Stock	100	...	...	...	85 — 88	85 — 88	85	
1,432,268£	Do. 4 % Mort. Deb. Stock Red. ...	Stock	...	...	...	105 —109	105 —109	...	..
300,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	12½— 13½	12½— 13½	12⅝	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	108 —113	108 —113	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	5¼%	...	...	99 —102	99 —102	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103 %	100 —103	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	...	8½— 9½	8½— 9½	9 3/16	8⅝
180,042	Do. do. 6 % Pref.	10	...	...	...	12½— 13½	12½— 13½	13⅛	12⅝
150,000	Great Northern Telegraph, of Copenhagen	10	...	15 %	...	27 — 29	27 — 29	...	...
75,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —103	99 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	35 — 39	35 — 39	38	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	100 —104	100 —104	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	2½%	...	...	¼— ⅜	¼— ⅜	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	5 %	...	...	⅞— 1	⅞— 1	...	...
983,333	National Telephone, Pref. Stock	100	5 %	5 %	5 %	95 — 99	95 — 99	...	...
200,000	Do Pref. shares	2	...	3⅛	3⅜	3¼— 3⅜	⅜— ⅜	...	...
1,966,667	Do Def. Stock	100	...	60	64 xd	60 — 64	60 — 64	60¼	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅞— 5⅛	4⅞— 5⅛xd	...	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	93 — 96	93 — 96	...	...
500,000£	Do. 4 % Deb. Stock Red.	100	...	4 %	4 %	101 —105	101 —105	103	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	6 %	...	⅞— 1	⅞— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	6½— 7½	6½— 7½	...	...
3,303	Submarine Cables Trust	Cert.	...	...	...	119 —125	119 —125	...	...
58,000	United River Plate Telephone	5	7 %	...	...	4⅜— 5¼	4⅜— 5¼	4 15/16	4⅜
40,008	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4½— 5	4½— 5	...	...
179,947£	Do. do. 5 % Debs.	Stock	...	...	...	102 —105	102 —105	102½	...
155,600	West African Telegraph, 5 % Debs....	100	...	...	...	99 —101	99 —101	99	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	⅛— ⅜	⅛— ⅜	...	...
150,000£	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	12 — 13	12 — 13 xd	12½	...
75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	102 —105	102 —105	...	...
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	99 —102	99 —102	...	...
88,321	West India and Panama Telegraph	10	⅜%	...	...	⅛— ⅜	⅛— ⅜	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	5 — 5½	5 — 5½	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	3½— 4½	3½— 4½	...	...
80,000£	Do do do 5 % Debs., Nos. 1 to 1,800	100	...	...	...	100 —103	100 —103	...	

ELECTRICITY SUPPLY COMPANIES.

100,000	Blackheath and Greenwich Dist. Electric Light, Ord. ...	1	...	...	...	⅜— ⅝	⅜— ⅝	...	...
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	...	...	...	100 —105	98 —103 xd	101	101⅜
19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	8 %	8⅜— 9¼	8⅜— 9¼	...	...
20,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8¾— 9¼	8¾— 9¼	8 15/16	8 3/16
50,000	Charing Cross and Strand Electricity Supply	5	9 %	9 %	10 %	9 — 10	9 — 10	9 1/16	...
50,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5⅝	5½— 5⅝	5⅝	...
250,000	Do. do. do. 4% Deb. Stock Red.	100	...	...	..	104 —106	105 —107	106⅝	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	5½%	4 %	5 — 5½	3½— 3⅝	5⅝	...
150,000£	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	110 —113	110 —113	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	4 %	0 %	5 %	8 — 9	8 — 9	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12 — 13	12 — 13	...	...
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	123 —128	123 —128	...	...
200,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	...	...	...	101 —104	102 —105	104	103½
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	4 %	4 %	4 %	8½— 9½	8½— 9½xd	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	12 — 13	12 — 13 xd	...	...
400,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	..	107 —110	107 —110	...	..
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	7 %	...	6 — 6½	6 — 6½	6⅝	6 5/16
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	6 — 6½	6 — 6½	6¼	6 3/16
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	..	...	...	106 —109	106 —109	...	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	11%	12%	10%	10 — 11	10 — 11	10¼	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 —104	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 2	1½— 2	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	...	...	4 — 5	4 — 5 xd	4½	...
250,000£	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	95 —100	95 —100	...	...
98,769	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	6¼%	14½— 15½	14½— 15½xd	...	...
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	111 —115	111 —115	...	...
250,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	98 —101	98 —101	...	...
8,652	Notting Hill Electric Lighting	10	7 %	7 %	6 %	14½— 15½	14 — 15 xd	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9	8 — 9	..	...
150,000£	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	1⅞— 2¼	1¾— 2¼	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	..	2 — 2½	2 — 2½	...	...
109,518	Westminster Electric Supply, Ord.	5	13 %	10½%	10½%	11 — 12	11 — 12	...	...

* Subject to Founders Shares.
† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
§ Dividends paid in deferred share warrants, profits being used as capital.
‖ Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotation Mar. 25th.	Closing Quotation April 2nd.	Business done week ended April 2nd, 1902. Highest	Lowest.
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	4⅜— 5⅛	4⅜— 5⅛	...	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	88 — 92	88 — 92	...	...
62,074	British Electric Traction	10	8 %	9 %	...	13 — 14	13 — 14	13⅞	12⅝
90,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12¼— 12¾	12¼— 12¾	12 9/16	...
600,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	126 —129	126	125
70,000	British Insulated Wire Ord.	5	20 %	15 %	...	9½ — 10⅛	9½ — 10⅛	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅝— 6¼	5⅝— 6¼	...	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	8 %	...	13s. to 15s.	13s. to 15s.	...	...
50,000	¶ „ „ „ 6 % Cum. Pref.	£1	...	6 %	...	16/6 to 17/6	16/6 to 17/6	...	...
105,731	Brush Elecl. Enging., Ord., 1 to 105,731	2	5½ %	5 %	Nil	½— 1	½— 1	1⅛	
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	3 %	1 — 1½	1 — 1½	1¼	1 9/16
125,060*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	101 —104	101 —104	...	...
125,000*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	97 —100	97 —100	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	17 — 18	17½— 18½	...	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	111 —115	111 —115	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	4 %	99 —102	101 —104	...	...
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	4 %	103 —106	103 —106	103⅞	102
440,100	Do. do. Def. do.	Stock	...	...	4 %	97 —100	97 —100	1⅛ 5	...
855,000	City and South London Railway	Stock	1⅞%	1½%	2 %	65 — 68	65 — 68	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	7½%	8 %	...	3 — 3½	3 — 3½	3⅛	...
100,000*l*	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —104	100 —105	103	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	2½%	...	⅛— ⅜	⅛— ⅜	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	2½%	...	2 — 3	2 — 3	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	78 — 83	78 — 83	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	83 — 88	82 — 87 xd	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅝— 1⅞	1⅝— 1⅞	...	...
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390... ...	2	...	...	...	2½— 3	2½— 3	...	...
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	97 —101	97 —101	...	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	9¾— 10¼	9¾— 10¼	...	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	100 —103	98 — 101xd	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	15 %	20 %	20 %	17½— 18½	17 — 18	...	...
35,000	Do. do. do. 4½ % Pref.	5	4½%	4½%	...	5½— 6	5½— 6	...	...
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	111 —115	111 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	21⅜	21
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	99 —102	99 —102 xd	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3⅜%	3½%	1½%	5 — 5¼	5 3/16— 5 5/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5	...	...	11 — 11½	11 — 11½	...	...
7,500	Parker (Thomas), Limited, Ord., Nos. 1 to 7,500 ...	10	...	...	...	15½— 16½	15½—16½	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	6 %	...	... — ...	19/- to 20/-	..	.
37,350	Telegraph Construction and Maintenance	12	15 %	17½%	20 %	35 — 38	35 — 38	37	35
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	... %	...	...	102 —105	102 —105	...	...
25,000	Telegraph Manufacturing, Ord. Nos. 1 to 25,000	5	12 %	12 %	...	10½— 11½	10½— 11½	11¼	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½— 6	5½— 6 xd	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	92 — 95	92 — 95	92½	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 3/16—3/16.
National Electric Free Wiring, 11/16—13/16.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 14½—15.
Do. do. Pref. (£10 pd.), 10⅜—10⅝.

* From Birmingham Share List. ¶ From Manchester Share List.

Bank rate of discount 3 per cent. (February 6th, 1902).

MARKET QUOTATIONS, Wednesday, April 2nd.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	22/-	22/-	..
a „ Oxalic	per cwt.	82/-	82/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a „ „ „ ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£13	£13	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a „ (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£20	£20	..
a Lead, Nitrate	per ton	£24	£24	..
a „ White Sugar	per ton	£31	£31	..
a „ Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8d.	8d.	..
a „ Caustic (75/80%) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£85	£85	..
a Shellac	per cwt.	117/-	117/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5	£6 5	..
a „ Recovered	per ton	£5 10	£5 10	..
a „ Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a „ Crystals	per ton	£8	£8	..
a Bichromate, casks ..	per lb.	2¼d.	2¼d.	..
METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b „ Wire, in ton lots	per ton	£224	£224	..
b „ Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £125	£75 to £125	
c Brass (rolled metal 2" to 12") basis	per lb.	6¾d.	6¾d.	..
c Tube (brazed)	per lb.	8¼d.	8¼d.	..
c „ „ (solid drawn) ..	per lb.	7d.	7d.	..
e „ Wire, basis	per lb.	7d.	7d.	..
e Copper Tubes (brazed) ..	per lb.	8¾d.	8¾d.	..
e „ „ (solid drawn) ..	per lb.	9d.	9d.	..
g Copper Bars (best selected) ..	per ton	£71	£71	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£71	£71	..
g „ Rod	per ton	£71	£71	..
e „ Electrolytic) Bars ..	per ton	£63	£63	..
e „ „ Sheets ..	per ton	£75	£75	..
e „ „ Rod ..	per ton	£68	£68	..
e „ „ H.C. Wire	per lb.	8d.	8d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f „ Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/1½ to 3/2	3/1½ to 3/3	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i „ Pig (Cleveland warrants) ..	per ton	46/11	46/9½	1½d. inc.
i „ Forgings, according to size	per ton	From £11	From £11	..
i „ Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i „ Wire, galvanised No. 8 ..	per ton	£9 15	£9 15	..
g Lead, English Ingot	per ton	£11 12 6 to £11 15	£11 7 6 to £11 8 9	5s. to 6/3 inc.
g „ „ Sheet	per ton	£18 10	.. ..	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 15	£8 15	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d „ „ „ medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d „ „ „ large ..	per lb.	3/8 to 7/8	3/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	11¼d. to 1/2	11¼d. to 1/2	..
p „ rolled bars & rods	per lb.	1/- to 1/3	1/- to 1/3	..
p „ „ strip & sheet	per lb.	From 1/2	From 1/2	..
o Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10d. to 1/-	10d. to 1/-	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i „ „ in bars		£58	£58	..
g Tin, block	per ton	£119 to £120	£118 to £119	£1 inc.
g „ foil	per lb.	1/6	1/6	..
w „ wire, Nos. 1 to 16	per lb.	1/6	1/6	..
p White Anti-friction Metals —				
"White Ant" brand	per ton	£85 to £86	£85 to £86	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j „ 4 ply Flax	per lb.	5½d.	5½d.	..
j „ 3 ply 10 lbs. Russian ..	per lb.	4 3/4d.	4 3/4d.	..
j „ 10 lbs. Russian, single ..	per lb.	4¾d.	4¾d.	..
j „ 180 lbs. Jute rope	per ton	£10 2 6	£10 2 6	..
k Zinc, Sheet (Vieille Montagne brnd.)	per ton	£22 10	£22 10	..

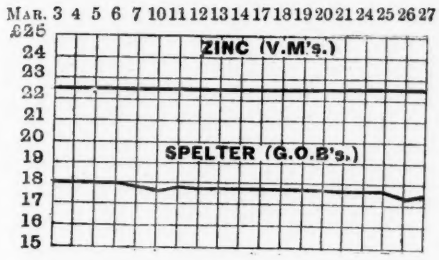
Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakespeare. [Co., Ltd. *h* Messrs. Edward Till & Co. *i* Messrs. Bolling & Lowe. *j* Messrs. Walter H. Hindley & Co.

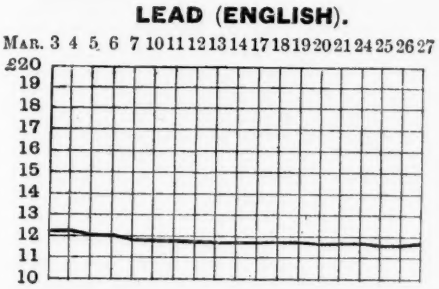
Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

METAL MARKET.

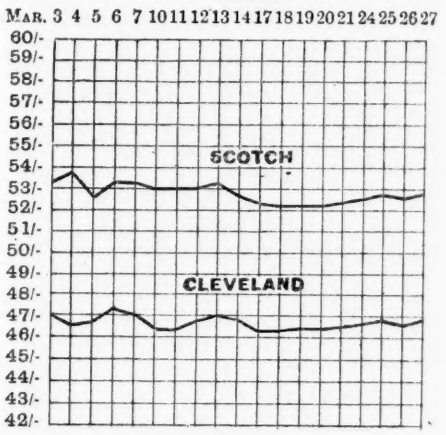
Fluctuations in March.



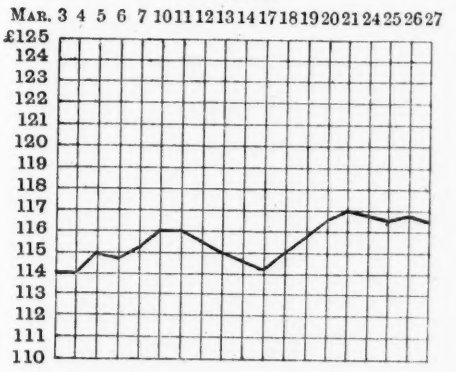
LEAD (ENGLISH).



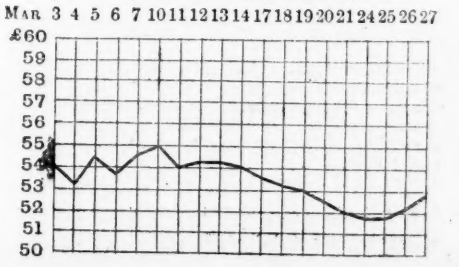
IRON.



TIN.



COPPER (G.M.B's.)



WIRELESS TELEGRAPHY AND SUBMARINE CABLES.

By E. GUARINI.

(*Concluded from page* 493.)

We will now see how duplex transmission can be realised with a coherer in submarine cables. We may say at once that duplex transmission is possible with a coherer in submarine cables, either by the differential system or by the Wheatstone bridge system.

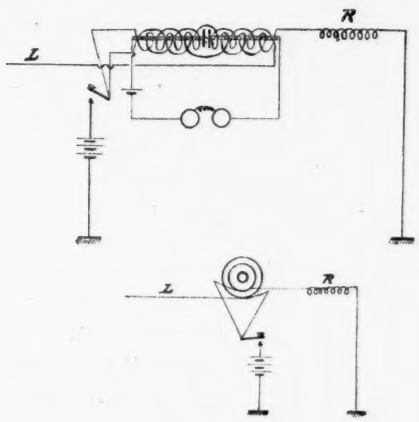


Fig. 11.

For the differential system we must devise a special coherer, a *magnetic coherer*, applicable, be it understood, to all the arrangements above described. Several experimentalists, in particular Messrs. Cervera, Tissot and Rochefort, regulate the sensitiveness of the coherer by magnetism. They use filings and electrodes of magnetised metal, and by making a magnet or electro-magnet act, vary the sensitiveness of the coherer, by regulating the magnetic

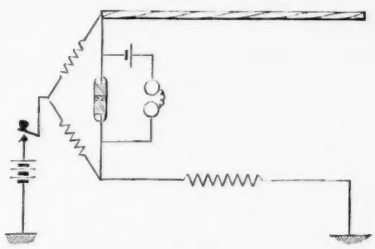


Fig. 12.

cohesion, *i.e.*, the pressure, of the filings. Thus Cervera regulates his coherer by means of an electro-magnet, the core of which consists of the electrodes of the coherer and the winding of which is put in circuit with a battery and a resistance capable of being regulated. Thus we see that a magnetic coherer can be obtained by constituting

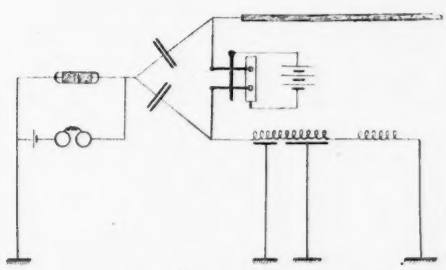


Fig. 13.

the winding of the line wire. A very sensitive magnetic coherer can be realised by composing it of very fine filings, and using in the circuit of the coherer a battery, the electromotive force of which is almost equal to that by which the coherer is acted upon. Then the least *compression* of the filings is sufficient to make the current of the local battery pass through. *Several times with Blondel coherers, with very fine filings and at the critical low-tension point, regulated to the highest degree of sensitiveness, it was sufficient to speak even gently on the tube for the current of the battery to pass.*

This being the case we have only to use a double winding for the electro-magnet of the magnetic coherer, each wire being wound in a

certain direction in order to realise (fig. 11) duplex transmission by the differential system. The arrangement shown in fig. 11 only differs from the ordinary system in that the magnetic coherer (with a battery and a relay or receiver in shunt) replaces the ordinary receiver. The Wheatstone bridge system is more easy of application. In order that equilibrium shall be absolutely perfect (for otherwise it would be necessary to use a less sensitive coherer, *i.e.*, one worked by a greater difference of potential), we have only to substitute a coherer for the ordinary receiver (fig. 12).

Fig. 13 shows the application of the coherer to the Anderson and Harwood method.

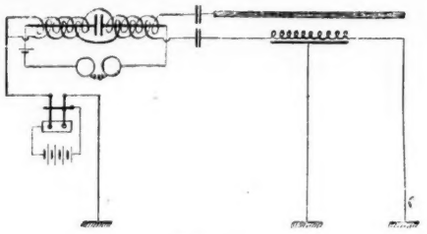


Fig. 14.

Fig. 14 relates to Stearn's differential method used by the Anglo-American Telegraph Company.

Lastly, fig. 15 shows the application of the coherer to Ailband's method, which is a combination of the differential system and the Wheatstone bridge system.

Another question which presents itself is the decohesion of the sensitive tube. This problem could be solved by *auto-decohering coherers*. Only it does not seem to me that these coherers effect the

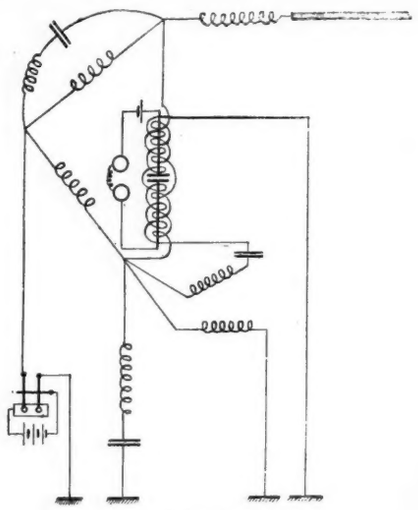


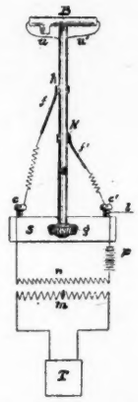
Fig. 15.

return with sufficient rapidity, owing to a certain inertia which has yet to be overcome. As to the ordinary coherers with metal filings which are made to return by the shock, they seem to me to act very slowly in comparison.

The arrangement which, in my opinion, would give the best results from the point of view of speed, is that described in my English patent, No. 1,555, 1900, and shown in fig. 16. In principle it consists in making the coherer vibrate continuously; for instance, by imparting a rapid rotary movement to it. The greater the speed at which the tube is made to rotate the more rapid is the decohesion. The above arrangement is not new in principle, since something similar was devised by Mr. Rupp in 1898 (*Electrotechnische Zeitschrift*, 1898, p. 237), and proposed by Mr. Brown in 1899 (English patent No. 19,710, 1899). Mr. Brown's patent, however, is later than my Belgian patent, dated June 24th, 1899.

This is the theoretical working of the arrangement:—"If the tube has lost its resistance it regains it again when it is shaken. If we conceive it in continuous motion, it will keep its resistance; if an electric wave strikes it, it loses its resistance for a moment to regain it immediately by reason of the motion imparted to it. We see that a coherer in continuous motion on being struck by electric waves reproduces with the same rapidity changes of intensity in the current in the circuit in which it is placed."

Of the three advantages to be gained by submarine telegraphy by using the coherer enumerated at the beginning of this article, the last two relate chiefly to new cables about to be laid. But as I have an absolute conviction that wireless telegraphy is well on its way to making sufficient progress to ensure communications satisfactory from all points of view, and that, on the other hand, cable companies will have the good sense not to sacrifice more capital without due reflection in establishing costly communication by means of cables which might be much more economically established by wireless telegraphy, we will not confine ourselves merely to the first advantage—increase in the speed of transmission.



B, Coherer; *u u'*, Connecting wires; *c*, Shaft set in motion by gearing; *h h'*, Contacts; *f f'*, Brushes; *c c'*, Terminals; *l*, Wire which conducts the variable current; *s*, Support; *p*, Battery; *n* and *m* primary and secondary of an induction coil; T, Telephone. The transformer *n* and *m*, and the telephone T, may be replaced by a relay or a receiver.

Fig. 16.

We may at another time examine how, by means of the imperfect contact, submarine cables can increase their efficiency by multi-communication.

INSTITUTION OF ELECTRICAL ENGINEERS.

NOTES ON INDUCTIVE CIRCUITS.

By W. Brew.

(*Abstract of Paper read at Dublin, January 23rd, 1902.*)

Introductory.

The effects produced with practical inductive circuits are full of interest to the electrical engineer, and perhaps in any particular case, this interest is not diminished by the fact that with possible distortions of wave forms and other disturbing influences, he is sometimes puzzled at the results obtained.

In practical work with large plants, effects are so magnified as to be noticed by an ordinary observer handling commercial instruments.

Inductive circuits may be classed under two general headings: "Ferric Circuits," and "Non-Ferric Circuits," according as they contain or do not contain iron.

Ferric Circuits.

When we handle large magnets certain phenomena become evident, for instance, if it be necessary to remove a portion of the magnetic circuit of a fair sized bi-polar dynamo immediately after working, it will often be found that the parts adhere firmly together, but that this adherence can be greatly diminished by a few smart blows from a hammer. Again, if the machine when running fully excited be quickly stopped, it will often be found on lifting the brushes that a current is still traversing the shunt winding and armature, although the latter may have ceased to move for some seconds. This is, of course, due to the gradual demagnetisation of the field magnet.

We have, in fact, in the shunt winding of a large continuous current dynamo, an inductive circuit of such magnitude, that, by means of an ordinary voltmeter and ammeter, we may readily observe effects which would require experimental skill to demonstrate with more delicate apparatus.

Taking the general definition that a circuit possesses unit self-induction when a current in it varying at the rate of one ampere per second induces an E.M.F. of one volt, we are met with practical difficulties in any particular case where a circuit contains iron in assigning to it any value of self-induction, for the counter E.M.F. induced in such a circuit by a varying current is affected by several quantities such as—

(1) The variation in the permeability of the iron with the current.

(2) Eddy currents produced in the iron of the circuit.

(3) The effect of the coercive force of the iron, which considerably damps the self-induction in rectified current circuits.

(4) The magnitude and rate of variation of the current, which if small and rapidly varying is practically unaffected by the presence of iron in the circuit.

The self-induction of a circuit at any instant is the ratio $\frac{d N}{d i}$, where N is the number of lines of force interlinking the circuit at that instant and i is the corresponding current flowing round it.

The self-induction of the field windings of a large continuous current dynamo for a given value of the shunt current can be determined as follows:—

Let the machine be run at a constant speed on open circuit, and let the shunt winding be suddenly connected across bus bars having a steady P.D. Take simultaneous readings of time and current and plot the curve $\frac{di}{dt}$. Take also time and volt readings between the terminals of the machine and obtain the $\frac{d\,\text{N}}{dt}$ curve. From these two curves values of $\frac{d\,\text{N}}{di}$ can be determined.

If the current through a choking coil, the P.D. between its terminals and the watts absorbed in it be observed, we find that

Watts = amperes × volts × a constant.

If the current and P.D. curves are truly sinusoidal, the constant is the cosine of the phase difference between the P.D. and current. If the curves are not sinusoidal the constant is the cosine of the phase difference between the "equivalent sine" P.D. and current.

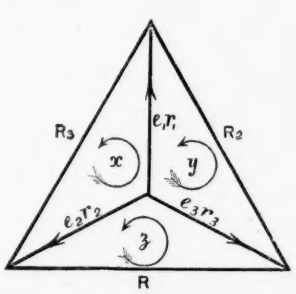
Non-Ferric Circuits.

In some of the old sub-stations in Dublin the low pressure bus bars on the transformer boards are coupled by rows of parallel cables to similar bus bars on the feeder boards.

In this case an interesting effect has been noticed—in that those cables, which are towards the centre of the series, become hot at times of heavy load, while those at the edges remain cool, although the cables are all of the same section and very approximately of the same length. The distance between the centres of the central pair of cables is 1 in., whilst that between the outermost pair is 1 foot, all the cables are 18 feet in length, and the cores are all 0·1 sq. in. in sectional area. The frequency of the circuit is 83 cycles per second. By calculation the self-induction of the central pair is 0·0022 henry, whilst that of the outermost pair is 0·005 henry. The resistance of each pair of cables is 0·003 ohm. It follows that the impedance of the outermost pair is nearly 0·006 ohm, while that of the central pair is only 0·0037 ohm. For the same P.D., therefore, a larger current will pass through the central pair than through the outermost pair. Hence the phenomenon is explained.

Polyphase Ferric Circuits.

In dealing with two direct E.M.Fs. acting in series upon a circuit, there are only two possible combinations in practice; the E.M.Fs. must either directly oppose one another or directly assist one another. With two alternating E.M.Fs. of the same periodicity, each having a $\sqrt{\text{mean}^2}$ value, E, we may also join them up in two ways, but between the extremes, zero and 2 E, we may get any intermediate values in the resultant pressure acting upon the circuit according to the phase difference between the two E.M.Fs.; this is well illustrated in the case of three similar transformers having their primary circuits coupled across each phase of a three-phase main. We can join up the secondary terminals of a pair of such transformers to give in one case a resultant pressure across the two of $\sqrt{3}$ times the pressure of either, or by reversing one of them we can obtain a resultant pressure across the two equal to that of either. Again, having joined up the secondaries of two of the transformers, the secondary terminals of the third transformer may be coupled in series with them in two ways, in one case, giving a resultant pressure equal to twice that of one of the secondaries, and in the other case zero. From this it would appear that with the three secondaries coupled according to the former arrangement it would be possible to convert a three-phase current into a single-phase current at a pressure $\frac{2}{r}$ times that between each phase of the primary circuits where r is the ratio of transformation of each transformer. In practice, however, complications arise as regards the transformers, and the natural relationship which ordinarily exists between the magnetising



component of the primary and secondary currents in the case of two of the transformers considered is seriously disturbed owing to the great phase displacements which exist between the single-phase current, which traverses in turn the secondary winding of each transformer, and the natural pressures induced in these secondaries by their primaries.

Polyphase Non-Ferric Circuits.

In the case of large transmission schemes the generators are usually star wound. The cables usually consist of three or more separate cores embedded in insulating material where an underground system is adopted.

Consider the arrangement of circuits shown in the accompanying figure, where e_1, e_2 and e_3 are any unequal E.M.Fs., and R_1, R_2, R_3 are any unequal resistances joined by equal resistances r_1, r_2, r_3 to a central point o. If we imagine cyclic currents x, y, z flowing in each mesh we shall find that the current flowing in any radial conductor, r_1 say, is

$$(1)\quad \Delta\,(x-y) = e_1\left\{2\,r\,(R_1+R_2+R_3)+R_1\,(R_2+R_3)\right\} - e_2\left\{r\,(R_1+R_2+R_3)+R_1\,R_2\right\} - e_3\left\{r\,(R_1+R_2+R_3)+R_1\,R_3\right\}$$

where

$$\Delta = 3\,r^2\,(R_1+R_2+R_3)+2\,r\,(R_1\,R_2+R_2\,R_3+R_1\,R_3)+R_1\,R_2\,R_3,$$

the values of $(y-z)$ and $(z-x)$ being obtained by interchanging coefficients.

We may now suppose e_1, e_2, and e_3 to vary harmonically with a phase difference of 120°, and to have equal $\sqrt{\text{mean}^2}$ values, E.

In the general case when $e_1 = \text{E}\sin\frac{\pi}{2}$

$$e_2 = \text{E}\sin\left(\frac{\pi}{2}-\frac{2\,\pi}{3}\right) = -\frac{\text{E}}{2}$$

$$e_3 = \text{E}\sin\left(\frac{\pi}{2}-\frac{4\,\pi}{3}\right) = -\frac{\text{E}}{2}$$

and $$e_1+e_2+e_3 = 0.$$

Substituting these values in (1) we get

$$(2)\quad \Delta\,(x-y) = \text{E}\left\{2\,r\,(R_1+R_2+R_1)+R_1\,(R_2+R_3) + \tfrac{1}{2}\left[r\,(R_1+R_1+R_3)+R_1\,R_2\right] + \tfrac{1}{2}\left[r\,(R_1+R_2+R_3)+R_1\,R_3\right]\right\}$$

which enables us to calculate the current in any core, r, of a three-phase cable, provided they can be considered as non-inductive. If balance exists, or $R_1 = R_2 = R_3$, then the above expression reduces to

$$(3)\quad x\,y = \frac{\text{E}}{\text{R}+\frac{\text{R}}{3}}.$$

If the load be arranged star fashion, we obtain under similar conditions the result

$$(4)\quad x\,y = \frac{\text{E}}{r+\text{R}}.$$

It is interesting to note that under these conditions of symmetry we need only consider one core and one section of the load, and we can imagine a return conductor having no resistance joined to the central points.

ELECTRIC FURNACES.

By Bertram Blount.

(*Paper read at Manchester, March 4th, 1902.*)

(*Continued from page* 528.)

In the second type of Cowles furnace hoppers and a tapping-hole are provided. They serve not merely for charging and drawing, but also for altering at any given point the amount of resistance material on the hearth, and thus controlling the heating effect of the current, and causing it to be approximately uniform from end to end. The idea of making the charge itself act as the resistance for converting electrical energy into heat energy precisely at the place required, was extended by the Brothers Cowles in the best known form of

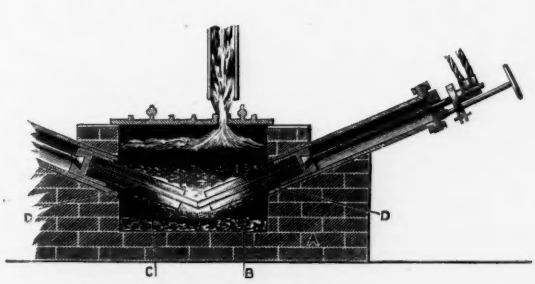


Fig. 8.

their furnace, viz., that which was employed for making aluminium alloys, especially those with copper. Here the granulated copper, mixed with the charge of alumina and carbon, served as a semi-continuous conductor, the contact surfaces of the constituent parts of which offered sufficient resistance to ensure the production of much heat when a current was forced through. The ultimate outcome of their ingenuity is shown in the figure (fig. 8), representing a furnace for making aluminium bronze. The parts are lettered similarly to those of the previous illustrations. This type of furnace was successfully used for some years, but at the best

it would only produce aluminium alloyed with copper and generally containing iron and silicon as impurities. The Héroult apparatus, which produces unalloyed aluminium, soon replaced the Cowles furnace even for alloys, because it was found to be better to prepare a definite alloy by mixing the pure metals in an ordinary furnace as is done for brass, gun-metal and a host of similar alloys. It is interesting to note that in the series of Cowles patents there is one describing the use of charcoal with a wash of lime over the fragments composing the lining. The idea is elegant, and in the days when it was first set forth calcium carbide was barely known. If the packing of charcoal reached a temperature sufficiently high—and it probably did—there remains the doubt whether its limed surfaces would not be converted into calcium carbide and thereby become fusible and conductive.

Having thus traced the origin of the two dominant types of electric furnace, I will give a brief description of a few examples belonging to one or the other class which exhibit points of individuality and interest.

Calcium Carbide Furnaces.

The Wilson furnace differs but little from the vertical form of Siemens, but is worthy of notice, because it was employed in the early days of carbide manufacture, although originally intended

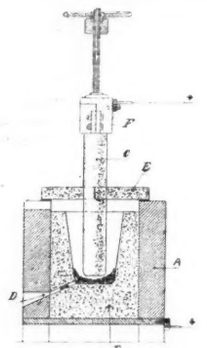


Fig. 9.

for the reduction of aluminium, a purpose for which it was eminently unsuited. As will be seen from the figure (fig. 9), its construction is of the simplest.

There is a casing of fire-brick A, a carbon vessel B, with a tapping hole D, and a cover E, through which passes a carbon electrode C, adjustable in height. The charge is introduced little by little, and as it is heated, fuses, forming a pool of calcium carbide, acting as the electrode, between which and the carbon rod an arc is maintained. The tapping hole allows the fused product to be run off, and thus should permit the furnace to be worked continuously. For the successful attainment of this end, however, a considerable modification is needed, the hearth being much shallower, and the tapping very frequent. The high fusing point of calcium carbide makes all continuous processes depending on its being run out from the zone of formation somewhat difficult to work. Thus it comes about that most carbide is "block" carbide.

Another furnace of a simple kind which has been found fairly effective in practice is shown in the accompanying figure (fig. 10).

Fig. 10.

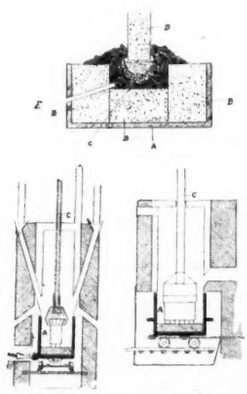


Fig. 11.

Fig. 12.

A is a cast-iron box lined with thick carbon blocks, B. The cavity C constituting the furnace proper is rather shallow; it is provided with a tapping hole, E. The upper electrode, D, is a massive carbon rod of square section. The lower end is just clear of the top of the box and of the fused part of the charge, the liquid carbide filling the box. The raw materials (crushed coke and lime) are fed by hand into and around the arc which plays between the upper electrode and the carbide in process of formation. By judicious feeding the arc can be smothered to some extent, but even at the best a great part of it is exposed, and a considerable loss of heat results. The upper electrode can be gradually lowered as it is consumed. The chief merits of the furnace are its cheapness and simplicity, and the fact that it can be worked continuously, the carbide being allowed at intervals to flow out at the tapping hole, and fresh raw materials being supplied round the upper electrode. A certain amount of hand labour is required, but it is not of a severe character. It will be seen that this furnace is not unlike the Willson furnace, but that no attempt is made to enclose the arc by the furnace walls. This is probably because in the Willson furnace the walls being conductive themselves form one of the electrodes and get unduly hot. A non-conductive refractory material, such as magnesia, might turn the balance of advantage in favour of the Willson form.

Another type of furnace is that designed to make "block" carbide. The King furnace is an example. (Figs. 11 and 12.) It consists of a brick chamber, through the top of which the end of the upper electrode C passes; it is fitted at the bottom with a truck A, which can be run into position and removed at will, and serves as the box to contain the carbide formed. The truck can be given a small reciprocating motion to help to shake down the charge, and to prevent the path of the current from being too localised. The raw materials are fed in little by little through side passages in the brickwork, and are exposed to the heat between the electrodes. The upper electrode is slowly raised, and thus a block of carbide is gradually built up.

A second form of block carbide furnace is that used by the United Alkali Company at Widnes.

The distinctive merits of this furnace are, that the upper electrode is continuously immersed in the raw materials, and that the vessel containing these is slowly rotated so as to bring every part of the charge into the zone of activity. Thus there is maintained a constant supply of raw material immediately beneath the upper electrode, and no arc can form. The furnace is of the resistance or Cowles type, and the waste involved by the use of an open arc is avoided. In this way a block of carbide is gradually built up by feeding in fresh raw material (which may be done mechanically) and raising the upper electrode. When the block is finished the operation is stopped, the front of the crucible opened, and the block removed. Adherent raw material from the sides and crude carbide containing admixed raw material from the top are knocked off, and the sound well-fused block carbide broken up for packing.

It will be observed that no attempt is here made to tap the carbide, and indeed it is doubtful whether this type of furnace could be used in this way without radical modification.

In general it may be said block carbide is inferior to tapped carbide, but that its manufacture is easier. There is more chance of the carbide made in blocks enclosing unconverted raw materials. It does not follow from this that the manufacture of block carbide is to be condemned. The inferiority of the product may be compensated for by a better utilisation of energy, and if the carbide is bought on its assay value, the consumer may be perfectly willing to buy the lower grade product at a proportionately lower price.

There are many forms of carbide furnace which, if examined with knowledge, might be grouped under one or other of the heads given above. It may be useful to consider on what lines a carbide furnace should best be constructed, and to attempt the design of such a furnace.

In the first place, the furnace should make carbide sufficiently fluid to be tapped and run away from the sphere of action. This requirement rules out block carbide, and makes the furnace of the continuous type. Next, it should not have an exposed arc, and the heat electrically generated should be conserved as much as possible. Thirdly, it should be so constructed that the containing vessel is hardly affected by the high temperature necessary to form carbide. I have endeavoured to embody these ideas in the furnace illustrated below (fig. 13).

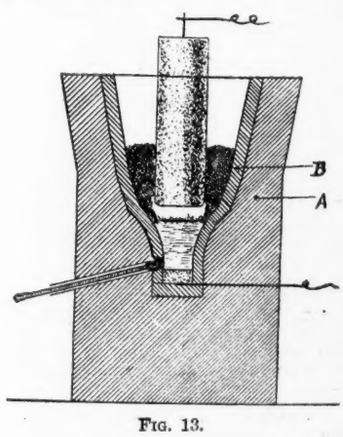


Fig. 13.

The furnace consists of a fire-brick casing A, with a magnesia lining B. The shape is conical, and at the bottom the furnace is contracted to form a hearth for the fused carbide. The tapping-

hole is at the bottom of this contracted part. The lower electrode is a carbon plate C, and the upper electrode a massive carbon rod D, of circular section. The raw material is fed into the annular space between the upper electrode and the magnesia lining in sufficient quantity to enclose and smother the zone of highest temperature. This feeding may be done mechanically, and various devices suggest themselves, but it is probable that hand feeding will be at least as effective, because the amount of labour required is not great, and the variation of conditions is so large that the greater elasticity of hand feeding may be a positive advantage For the safety of the workmen it may prove necessary to draw off the carbon monoxide by a fan through a side flue, leaving the top of the furnace open and uninterrupted for manipulating the charge. In operating the furnace a pool of carbide will be formed and maintained of such depth as to cover the hearth and to allow of tapping the pure and fairly fluid product, but the depth of this pool will be kept small, and special attention will be directed to maintaining its fluidity by the means indicated below. It will be observed that the cross-section of that part of the furnace immediately surrounding the lower end of the upper electrode is considerably greater than the cross-section of the hearth on which the carbide collects. Thus the smaller section of the column of carbide compensates for its conductivity being greater than that of the raw materials; the desired temperature can be maintained, and the carbide will remain sufficiently fluid to be tapped.*

It is evident that a furnace of this description, which is continuous and has a large part of its contents at so high a temperature as to be fluid, can hardly be worked on any system which depends on the raw materials forming a protective lining, for this, from the nature of the case, cannot protect the hearth or crucible where a pool of fused carbide is always present. That part at least must therefore be protected by a refractory lining. Carbon might be used but for its conductivity, which would allow the current to reach the upper electrode without passing through the fused carbide, leaving this comparatively cool and liable to solidify. Magnesia is the most suitable material. It is not reduced by carbon, does not yield a carbide and is extremely infusible. It is not a good non-conductor of heat, but the difficulty thus caused can be overcome by supplying the lining with a backing of fire-brick, as shown in this figure. I am of opinion that this will be the type generally adopted as long as the carbide industry is at its present somewhat crude stage. If it is found feasible to heat the raw materials by non-electrical means to a point approaching the temperature of formation of carbide, then to raise them through the last 1,000° C. or so electrically, to work regeneratively, and to utilise the bye-product carbon monoxide, the aspect of affairs will be profoundly changed. Until then the simple type of furnace described may be considered as an attempt to meet present needs in a rational manner.

(To be concluded.)

* It is curious that no one appears to know the fusing period of calcium carbide. Moissan speaks of it being liquid at a red heat, but those who have seen it tapped from a carbide furnace will probably agree that this is an understatement. I have failed to fuse it in an injector furnace capable of giving a temperature of 1,200° C.

ELECTRICAL MATTERS AT THE LONDON COUNTY COUNCIL.

The Council, at its meeting on Tuesday last week, resolved to lend £7,295 to the Hammersmith Borough Council and £4,873 to the Islington Council for electric lighting purposes.

Shallow Tramways and Tube Lines.—The Parliamentary Committee reported that the Council's Subways and Tramways Bill, which sought power to enable the construction of a subway from Victoria Embankment to Southampton Row, had been read a second time in the House of Commons. It was originally proposed in the Bill to obtain a general power to make subways for the reception of pipes and wires, and to work tramways therein. These proposals, however, gave rise to considerable opposition, and it was thought advisable to arrange for the withdrawal of these clauses.

With regard to the tube railway Bills, the Committee stated that every effort had been made by the Council with a view to some action being taken in the sense of a more direct control and supervision being obtained of all projects for such underground railways, as suggested by the Joint Committee of Parliament of 1901. The Committee had communicated with the President of the Board of Trade, and a deputation from the Highways Committee, which waited upon him on the subject of shallow tramways, had also adverted to the matter, and the Committee gathered that the President would give favourable consideration to the question next session. In the meantime the Committee mentioned that a report on the whole subject of tube railways would be presented after the Easter vacation.

Mr. Verney drew attention to the fact that the Joint Parliamentary Committee suggested the institution of more direct control over underground electric railways. He contended that the proposal should be extended so as to include the control of the construction of the railways in such a manner as to cause the least possible annoyance to neighbouring owners and occupiers in consequence of vibration. The report of the Committee, of which Lord Rayleigh was chairman, stated that vibration could, to a large extent, be stopped by proper construction, and in order that the Council might register its opinion on the subject, the speaker proposed that the report should be referred back to the Committee.

Mr. J. W. Benn seconded the amendment, on the ground that the question was entitled to more consideration than could be given on that occasion.

Mr. McKinnon Wood remarked that the object of the Committee in bringing forward the report was to show that the Council had done its best in order to secure that the question of underground railways should be dealt with on some comprehensive scheme. The subject had been pressed upon the attention of the Government, and although nothing had at present been done, the Committee desired to make it perfectly clear that it was not the fault of the County Council. He agreed that the report should be taken back by the Committee.

The amendment, on being put to the vote, was carried.

Lighting of Places of Entertainment.—The Theatres Committee reminded the meeting that the revised regulations approved last July did not contain any clauses in regard to the electric lighting and heating arrangements at places of public entertainment. As soon, however, as regulations had been prepared, the Committee submitted them to the London Entertainments Protection Association for consideration and suggestions. An electrical expert had been appointed by the association to confer with the Council's engineer, and as a result some slight modifications were proposed, which the Committee were able to accept almost in their entirety. The regulations had been amended, and were now in accordance with the views of the association, and on the recommendation of the Committee the Council resolved to approve them.

The Council resolved to approve plans for the extension by the Woolwich Borough Council of the generating station in White Hart Road, Plumstead. It was decided to retain the system of wireless telegraphy between the street fire brigade station at Streatham Green and the temporary fire station in Mitcham Lane until the completion of the new Streatham station, on the payment of £25 per annum to Marconi's Wireless Telegraph Company.

PHYSICAL SOCIETY.

Ordinary Meeting, held March 14th, 1902.

Mr. S. Lupton, Vice-President, in the Chair.

A paper on "The Thermal Expansion of Porcelain," was read by Mr. A. E. Tutton.

The Secretary then read a paper by Mr. W. Williams on "The Temperature Variation of the Electrical Resistances of Pure Metals and Allied Matters."

In the first part of the paper an attempt is made to correlate the periodic variations which pure metals exhibit as regards their atomic weights, chemical valencies, melting points and electric resistances. If m is the chemical valency, v the atomic volume, θ the absolute temperature, T the absolute melting point, and c, or $v^{\frac{1}{3}} a t$, the constant of Pictet's Law, then $\sigma \propto \frac{m v \theta}{c T}$ where σ is the specific resistance at 0° C. This relation holds for most of the metals, but fails for gold, iridium, tin, and aluminium, and also for metals of the iron group. The temperature resistance coefficients of pure metals are not equal to $\frac{1}{273}$, and an expression for the change of resistance with temperature has been deduced which holds approximately for many metals. The author also obtains simple expressions for the average increment per degree of the specific heat of metals, and for the ratio between the specific resistances of the solid and liquid states of a metal at the temperature of fusion.

A paper entitled "A Suspected Case of Electrical Resonance of Minute Metal Particles for Light Waves: A New Type of Absorption," by Prof. R. W. Wood, was read by the Secretary.

Experiments on which the author has been engaged have led him to believe that he has found a new type of light absorption, which it may be possible to refer to the electrical resonance of small metallic particles for waves of light. Metallic deposits on glass have been produced which are shown by the microscope to consist of particles less than the wave length of light, and which, by transmitted light, exhibit colours as brilliant as those produced by aniline dyes. The author has sought to explain these colours by interference and diffraction, and has been forced to accept the hypothesis suggested in the title of the paper. The metallic deposits can be obtained by heating small fragments of the alkali metals in exhausted glass bulbs, when the vapour condenses on the cold parts of the bulbs and forms the films. It can be shown that the colours are due to the presence of metallic sodium (in the case in which sodium has been used) by allowing air to enter the bulb; oxidation takes place and the film vanishes. In some experiments the air has been allowed to enter very slowly, and the changes which the film undergoes before it vanishes have been examined. The particles which form the deposits can be classed under three heads:—(1) Coarse particles which diffract or scatter light and give the bulb a silky lustre; (2) minute particles very close together, which regularly reflect those wave lengths absent in the transmitted light, but give no scattered light; and (3) minute particles far apart which diffuse light of the same wave lengths as those which are, to some extent, absent from the transmitted light.

By observing the spectrum of the transmitted light the author has examined the changes in colour which accompany changes in temperature of the films. The paper gives an account of the relation between the colour of the film and the size and distribution of the particles, and also of the behaviour of the films with polarised light. Experiments upon the electric resistance of the films have proved that they are non-conducting. The author concludes by stating that at the present stage it is impossible to decide either in favour of or against the theory of resonance. The idea of resonance has proved a useful working hypothesis for explaining some of the phenomena described in the paper.

The Secretary read a letter from Prof. R. Threlfall, drawing the attention of the author to some experiments upon the same subject published by him in 1894. Particles of gold and platinum were deposited in a liquid, and good scattering of light obtained in all cases. The polarisation angle was exactly the same as with non-conducting particles. Prof. J. J. Thomson has shown that the peculiar scattering effect is only to be expected within very narrow limits as to size of particles. The colours observed by Prof. Wood should only be noticed when the particles have a very restricted size, and evidence in favour of or against the author's theory should be afforded by comparing the observed and calculated sizes of the particles. The value of the polarisation angle of the scattered light observed by Prof. Wood is evidence in favour of the theory suggested.

The Chairman pointed out that the experiments had probably been rendered difficult by the different colours in which the oxides of sodium and potassium can exist.

The Society then adjourned until April 11th.

SOME OBSERVATIONS ON SWITCHGEAR.

By C. C. Garrard, Ph.D.

In a recent paper read before the Institution of Electrical Engineers (Manchester Section),* Mr. H. W. Clothier has given an admirable classification of the various forms of switchgear at present in use, and called attention to several points in connection therewith. Perhaps the most necessary property which a switchgear should possess, is that in performing the operations for which it is intended, it should not cause rises or surges of potential in the circuit. This is most important with high-tension systems in which the factor of safety of the insulation is necessarily lower than on low-tension systems. It is to be feared that this subject has not been given the attention that it deserves, as is to be seen in the switchgears manufactured by some of the leading firms which are eminently unsuitable for the purposes for which they are made. It is, indeed, very difficult to get reliable information as to the action of the switchgears at present installed in our central stations. This is due to the fact that if care be taken it is very seldom necessary to use the switchgear of a station to the full extent and to carry out the operations for which it is supposed to be designed. Thus it is often usual in high-tension and extra-high-tension stations never to use the generally elaborate charging gear provided for bringing the feeder cables up to full potential. The feeders are either left continually connected to the bus bars, or else, if it be desired to connect a cable up, the bus bar voltage is lowered and the cable run up on the machines. This, of course, necessitates the lowering of the voltage of the entire system for a short interval of time.

The writer has recently made some experiments, the object of which was to find out what would be the effect of allowing arcs to occur in a circuit possessing capacity, that is to say, allowing the capacity of a high-tension cable to play across an air gap, forming an alternating current arc.

A quarter of a mile of B.I.W. 7/20 lead-covered high-tension concentric cable wound on a drum was taken, and at one end the inner conductor was connected through a horn switch provided with a brass block, which made connection between the two horns, in series with a standard Ferranti oil break switch, to one end of the high-tension side of a 5-kw. transformer. The other end of the high-tension winding was connected to the outer conductor. The other end of the cable was provided with an adjustable spark gap between inner and outer. The transformer was run off a copper type alternator, which gave a nearly true sine curve. The voltage on the cable was 4,000 volts. The spark gap at the far end was adjusted with a sufficient margin so that it did not spark across at the normal voltage. The charging current of this cable is, of course, very small, and a sufficiently low reading ammeter was not at hand to measure it; the presence of a capacity current, however, could be seen in that an arc occurred when the horn switch was opened. On raising now the brass block which made connection between the two horns, this arc could be gradually increased in length from zero upwards, and it was found that at a particular length of arc the spark gap at the end of the cable invariably sparked over. There was no question of the arc breaking and thus causing the spark gap to go; always when the arc was a certain length the sparking at the gap took place. This is, of course, perfectly analogous to opening this high tension alternating cable circuit by any form of open flare switch. If now the horns were shorted and the circuit opened by means of the oil break switch no sparking at the gap occurred. The result that the arcing switch, under the conditions present, caused rises of P.D. in the cable was very conclusive. As to an explanation of this phenomenon, the following consideration may be of service. The condition of stability of an electric circuit is that its $\frac{\delta v}{\delta a}$ should be positive (v = volts, a = amperes). Now an arc in air is an electric circuit whose $\frac{\delta v}{\delta a}$ is very liable to be negative—this being the reason that an arc lamp, for example, will only run with a balancing or steadying resistance in series with the arc. The same thing applies to the filament of a Nernst lamp when overrun. In drawing out an arc in the above cable circuit the condition is possible, at a particular length of the arc, in which the positive $\frac{\delta v}{\delta a}$ of the circuit is more than counterbalanced by the negative $\frac{\delta v}{\delta a}$ of the arc, the result being that the whole circuit is rendered unstable, and an abnormal rush of current occurs, which charges up the cable to a higher voltage, eventually breaking its insulation down at its weakest point, in this case the spark gap. It would seem that an effect such as this is different to that produced by breaking an inductive circuit suddenly. As has been recently shown by Steinmetz, this is due to the energy of the induction suddenly collapsing on to the conductor, and charging it up electrostatically. In this connection the difference between the action of an oil break switch on alternating and continuous current is very marked. Experience has shown that an oil break switch, which will act perfectly well for breaking 400 to 500 kw. at 6,000 volts alternating current, will fail to act on 2,000 volts direct current, at loads from 100 to 200 kw. The oil break switch is, in fact, with alternating current, not a quick-break in the true meaning of the word. An arc is drawn out for a certain very short interval of time underneath the oil. This arc can be looked upon as a mechanically weak conductor, upon which the oil presses and tends to rupture. Naturally the arc is mechanically weakest at the point where no current is passing; at this point the pressure of the oil overcomes the arc, and extinguishes it. The first time therefore the current crosses the zero line, the arc is put out. The current at this instant being zero, no rise in potential due to induction can occur. It is easy to see from this that the maximum energy required to be absorbed by the oil is that of half a complete cycle. Provided the amount of oil be kept above this minimum, no danger of firing of the oil is to be feared. As a matter of fact, all good oil-break switches have a large factor of safety in this respect, and the great advantages they possess, in every way, over open flare switches for high tension alternating current systems are becoming generally recognised.

* See Elec. Rev., March 7th, *et seq.*

REVIEWS.

Class List and Index of the Periodical Publications in the Patent Office Library. London: 1902. Price 6d.

This is a guide to the consultation of back numbers of periodicals, which have been arranged in the new library at the Patent Office in such a manner as to be very much more

accessible to the public than was formerly the case. In passing, we wish to draw the attention of our readers to the admirable arrangements made for their comfort and convenience in the new building; the library is housed in a lofty, well-lighted hall, with glazed roof, round which the books, periodicals, &c, are arranged on stacks of shelves, on the ground floor and two galleries. Current periodicals are placed on tables on the ground floor, between which are dwarf presses containing the back numbers of the current volumes in boxes. The bound volumes of periodicals are shelved on the first and second galleries, where they can be consulted without the intervention of an assistant.

The class list contains an explanation of the system of classification, a classified catalogue, and an alphabetical title index. The classification consists of 10 primary classes, with sub-divisions, the class marks including information as to the size and the date of the first volume of a work; this greatly simplifies the labour of a search for novelty or historical research, as the reader can confine his investigations to any given period. The handbook also gives information enabling any person readily to find almost any desired periodical on the shelves, without other aid. This is a specially valuable feature, as the necessity of summoning or applying to an attendant would probably be felt as a serious deterrent by those who are engaged in protracted and extended searches. The clear arrangement and printing of the handbook are no less commendable than its admirable object.

Wireman's Pocket-Book. Edited by F. C. Raphael. London, 1902: The *Electrician* Printing and Publishing Company, Limited. Price 5s. net.

We are glad to meet with a wireman's pocket-book which appears to be really well compiled and arranged, and of a handy form. Departing from the tradition which decrees that pocket-books shall be of an awkward shape, unfit for the pocket, and shall open top and bottom, the editor makes his book 8 in. × 3½ in. × ½ in., and opens it in the normal and rational manner. It is perhaps a trifle long, and might have been a little wider, and the paper is too thin; but still, it marks a step in advance. Opening it, our first thought is for the index; this does not strike us as too complete. The first test we apply is "Price's Guard Wire," but our search is fruitless; even in the section on "Testing Cable" (which *is* indexed), we find no word of it. Yet this invaluable (we could not say priceless) aid to the testing of insulation resistance is a household word in every cable testing room. A similar search for that almost equally useful device, Ayrton and Mather's Universal shunt, was no less unprofitable. "Lead-covered cables" was immediately successful, excellent tables of data relating to all kinds of cable being given; "joint boxes," "vulcanised rubber joints," "tubes for house wiring," "distribution boards," "fuses," "outlets," "meters," and other test words proved the keys to abundant and concise information on the various subjects concerned. The book, we may mention, is intended for the use of the wiring contractor and mains superintendent, as well as the wireman.

The tables are of unusual merit and originality; the standards of the Committee on Copper Conductors, international ohms, &c., are adopted throughout; and the book is divided into six sections:—House wiring; underground lines; overhead lines; electric bell and interior telephone wiring; miscellaneous, and house-wiring estimates, so that the respective data are kept as far as possible together. A handy table of fall of potential and current density in conductors supplying stated numbers of lamps is given, with others of similar nature. The instructions for jointing are clear and the sketches good. An obvious error occurs in fig. 25, both of the lamp leads being coupled to the + main. Amongst four fuse tables is a new one giving the correct sizes of fuse wires for various numbers of lamps. In addition to the I.E.E. and Fire Office wiring rules (the Phœnix reproduced in full, and filling 25 pages!), a list of British electricity works is given, with their supply pressures, and choice extracts from their respective codes of regulations.

The sub-section on testing house-wiring consists largely of illustrations of standard testing sets, with the makers' instructions; the telephone test is also described. Various patented systems of wiring are dealt with at length, and a large space is given to all kinds of supply meters. In the "underground" section full tables of cable data are given, with a sketch of a variety of distributing systems, including polyphase systems and arc lighting. Various methods of cable laying, solid, direct and drawn-in, follow, with illustrated descriptions of manholes, joint boxes, and jointing. A few tests for cables and faults are described, and the B. of T. regulations are reprinted. This section ends with a short account of underground telephone and telegraph wires.

The section on overhead wires calls for no special remark. That on bell and telephone wiring is both novel and useful; the subscriber's station connections are given, for both the National Telephone Company and the Post Office. Arc lamps, lightning conductors, primary cells (why "batteries"?), accumulators and weights and measures occupy the "miscellaneous" section.

The section on estimating is specially written by Mr. Justus Eck, and is, therefore, practical and useful; it consists mainly of three complete examples of estimates and schedules, including prices. Our only fear is that by this means the enterprising ironmonger and plumber will be tempted to call themselves electrical engineers, with the usual result of cut prices and Carey Street.

Lastly, we must repeat our opinion that this is certainly one of the most useful books of the kind on the market; we have observed hardly any errors—nor did we, as a matter of fact, expect to find many. We cordially welcome the manual as a real acquisition to the industry.

Water-Tube Boilers. By Leslie F. Robertson. London: Jno. Murray, Albemarle Street, W. 1901.

This volume is the outcome of a course of lectures by the author at University College, and is presented as a popular book on water-tube boilers.

There are three columns of the index filled with the names of different water-tube boilers, yet, curiously enough, we see neither the Cummins nor the Weir boiler. The latter is perhaps the most perfected type of all, and it can scarcely have been unknown to the author, who mentions the Weir pump and the feed water regulator and feed heater. The history of water-tube boilers is given, and anyone who wants to know the many phases through which water-tube boilers have passed can learn them from these pages. Here we may find the early forms of the Belleville boiler and the Babcock, and we may trace the influence of the necessity for circulation, as it appears in some types, while the belief that nothing is needed to secure circulation is well shown in the view of that type of boiler to which the Admiralty has sacrificed the safety of the country. At page 77 is shown, and well shown, the economiser type of Belleville that was adopted after the *Terrible* fiasco.

No engineer could examine this drawing and fail to see the radical impossibilities of the boiler. But we find nothing controversial in the book. It contains simply information, figures, and illustrations, but does not attempt to guide the reader in his choice, or to influence opinion, though on p. 56 there is really a very strong statement about the bad circulation in this boiler. The interim report of the Boiler Committee is printed at the end of the book. Many of the boilers described can only have been designed by men who paid very little attention to scale and its difficulties.

The author admits that water-tube boilers have disadvantages, but sees no reason why, in the Navy, at least, they should not in time prove equal in durability to the cylinder type. He admits that the feed must be absolutely pure, and the circulation must be good. The old chestnut about the the battle of Santiago is brought in, as it often has been, to cover the neglect of Uncle Sam in blockading an enemy's fleet within a harbour whence they were expected to issue, and did actually issue, to catch Uncle Sam with half his boilers cold. Certainly, the battle of Santiago taught not the absolute necessity for water-tube boilers, but the folly of not boldly attacking ships which would have been an easy prey, instead of bolting and giving them a chance to wake up and give chase.

There is a good deal of information scattered throughout the book on forced draught, rates of combustion, feed regulation and general performances of boilers. Nor is the book entirely given over to marine work. We find the

Stirling boiler with its brick walls and an evaporation credited at 13·03 lbs. from and at, which seems large.

Generally, we think the author has well succeeded in presenting his subject. He shows practically all that has been done, though he makes some omissions as indicated. He does not enter closely into questions of combustion, but leaves his readers simply in possession of the history and present state of the water-tube boiler.

When it has become a matter of history, the public may begin to learn the truth about our naval boiler question. Could it be made public we do not doubt it would afford curious and, perhaps, useful, reading. Meanwhile, any use that might be made of the failures is being lost, and people who see 43 boilers of a condemned type put into the *King Alfred* must entertain curiously mixed feelings as to the committee that condemned the boiler, or the officials who stick to their follies and mistakes.

Méthode Pratique pour calculer les Moteurs Asynchrones Polyphasés. By Boy de la Tour. Paris: C. H. Béranger. 1902.

This book has been written, as the author states in his preface, for those who have not had the opportunity of following a course of lectures on the subject, and who, for want of sufficient knowledge, are not able to benefit by articles which appear in scientific journals. The book is consequently of an elementary nature, and difficult mathematical treatment is carefully avoided.

There are eight chapters, comprising in all 216 pages. Starting with an explanation of the production of rotating magnetic fields by means of di-phase and tri-phase currents, the author proceeds to show how to calculate the electromotive forces induced in the rotor windings, and explains the various methods of winding the rotor coils. The third chapter considers the torque exerted on the rotor, and the magnetising action of the stator windings. The fifth chapter is devoted to the calculation of the resistance of the short-circuiting rings in squirrel-cage rotors. It is pointed out that a large proportion of the rotor resistance is due to the short-circuiting rings since the current density may be much higher in those than in the bars themselves. The question of magnetic leakage is dealt with in the seventh chapter, and is very thoroughly discussed. The last chapter contains the designs of three different motors, the designs being carried out to specifications, *e.g.*, the specification for the second design is as follows :—

"A tri-phase motor is required to develop 3 H.P. at 190 volts between the lines, and at a frequency of 50 cycles per second. The speed is to be 1,440 revolutions per minute, the efficiency 85 per cent., and the power factor 0·83; also the starting must be effected simply by the closing of a switch, and the starting torque must be double the normal full-load torque."

The calculations of the design are completely carried out, and are very instructive and useful to those engaged in the manufacture of polyphase motors.

The great drawback to the book is the omission to treat of monophase induction motors. So many of these are manufactured, that no book on induction motors is complete which does not include a treatment of them. Perhaps, when the author has to revise for a second edition, he will supply the missing chapter.

The book is well worth reading, as it fulfils the promise given in the preface, and should be intelligible to those whose theoretical instruction is not of a high order.

Tramway Companies and Local Authorities. Being a collection of special provisions contained in private Acts of Parliament of tramway companies, and relating particularly to the interests of local authorities. By Frank Noel Keen, of the Middle Temple, Barrister-at-law, Parliamentary draughtsman. Crown 8vo. Price 10s. net. London: Merritt & Hatcher, Limited.

The phrase, "This work supplies a long-felt want," is frequently used by the reviewer who wishes to praise some work which is brought to his notice. We think it is particularly apt in relation to Mr. Keen's book. In his preface the author says :—"Having found in practice the need for frequent use of precedents of special tramway clauses, and the difficulty of readily finding suitable ones in the absence of a classified arrangement, I presume that others have found the same need and difficulty." The learned author is right in his presumption. If it is difficult for a Parliamentary draughtsman to find his way about in the private Acts of Parliament, the task is very much more burdensome to the layman. Six or seven huge volumes of private Acts are passed in each year. A diligent search through them may result in the discovery of a clause which will act as a precedent, but with Mr. Keen's book at his elbow, anyone who is interested in the relationship between tramway companies and local authorities may find exactly what he wants in two or three minutes.

The body of the work comprises nothing more than the text of numerous clauses from different private Acts of Parliament arranged under headings in a systematic manner, with references to the Acts from which each clause is taken.

The arrangement of the work may be seen at a glance by referring to the Table of Contents, which deals with :—(1) Method of construction and alteration of tramways and period of completion; (2) Construction, maintenance, use, alteration and discontinuance of plant and apparatus; (3) Widening, alteration and improvement of roads and bridges; (4) Making-up, paving, maintenance and repair of roads and tramway track; (5) Interference with, and injury to, drains, pipes, wires, roads, bridges and other property of local authorities; (6) Approval of plans, giving of notices and superintendence of works; (7) Working and use of tramways and rolling stock and regulation of traffic on tramways; (8) Supply of electricity to and by company and erection of generating stations; (9) Purchase of tramways by, and annual payments to, local authorities, sales and assignments by company, acquisition and grant of leases and running powers and making of junctions and crossings; (10) Agreements between company and local and road authorities as to various matters; (11) Miscellaneous provisions.

The relationship of tramway company and local authority could not be adequately treated of at the present day without reference to electricity. Hence we are not surprised, and at the same time are very pleased, to find a number of clauses in Mr. Keen's work which will be of great value to electrical engineers. Such matters as the height of overhead wires, injury to pipes through electrolytic action, the use of trailer cars and the prevention of noise and vibration at generating stations are all dealt with.

The author makes no apology for the absence of an index, and it is true that the form of the work is such that it is practically an index in itself.

We heartily recommend Mr. Keen's work to those who desire enlightenment upon the intricacies of private Bill legislation.

Simple Electrical Working Models. Edited by P. Marshall, A.I.M.E. London: Dawbarn & Ward, Limited. Price 6d.

This little book, one of the "Model Engineer" series, gives instructions for the construction and use of model telegraph instruments, bells, telephones, induction coils and motors, using the simplest materials and tools. The educational value of model-making needs no emphasis, and this appears to be an especially clever collection.

A similar volume is entitled *Simple Mechanical Working Models*, covering various forms of prime motors, such as wind and water wheels, hot-air engines, locomotives, steamboats, &c. The instructions are clearly the result of the author's actual experience, and can therefore be relied upon.

POWER REQUIRED TO DRIVE MACHINERY.

Some recent tests made on machine tools and shafting showed that 60 ft. of 2-in. shafting driving 17 countershafts with from one to three belts each required 5 amperes to drive at 150 revolutions per minute, the current being supplied at 500 volts.

To cut hard cast-iron required 6 amperes, the cut being $\frac{1}{4}$ in. $\times \frac{1}{16}$th in., and the cutting speed 100 ft. per minute with one of the new special tool steels.

A 20-in. drilling machine, run without cut, absorbed 1 ampere. A circular milling machine, run on cut, took 1 ampere, and idle it absorbed 0·5 ampere only.

A spur-gear cutting machine required 0·75 ampere idle, and 1·25 amperes when cutting teeth of about §th in. pitch three at once.

A 6-in. lathe only absorbed 0·25 ampere idle. Except the heavy boring-mill with 30-in. table, which did the heavy cast-iron cut, the machines cited were all of light type. Generally, it may be said that machine tools of the light order require very little power to drive them, and there is not much present reason for applying separate motors to them. The 60 ft. of shafting cited above was driving 17 machines, all placed on one side of the shaft. It could drive an equal number of machines placed on the opposite side of the shaft, or, say, one machine to each 2 ft. of shafting. As the belt pulls would balance on opposite sides, the total current for 34 machines and their countershafts would probably not exceed 8 amperes, or, say, 0·25 ampere per machine. Where machine tools are busy, it will not pay to drive them by separate motors—it will be better to group them on shafting. Nothing, of course, should interfere with the grouping of the machines to secure the best arrangement of work.

Where one shaft drives a number of similar machines, there is some economy to be secured by coupling it up in several lengths, so that in the event of a slack period, or of overtime on a few machines only, the line shaft may be uncoupled beyond the few machines needed. Where it can be arranged, the motor should drive upon the middle of the shaft, but very frequently it is more convenient to arrange the motor to drive from the end. Driving the middle point of a shaft enables its diameter to be reduced in the ratio $1 : \sqrt{2}$ with reduced friction nearly in the same ratio.

When a shaft drives different kinds of machines, all operating on the same pieces, it may be both possible and convenient for the machines to be mixed together all along the shaft, instead of being grouped in sets of A, B, C, &c. Then at slack periods some of each machine can be driven off one section of the shaft, the remainder of the shaft being uncoupled for economy of power. This point is, of course, to be secondary to shop economy, but may well be attended to if other economies permit of it.

No bevel wheels should be permitted for coupling shafts at right angles. Each shaft must have its own motor. Heavy machines should not be grouped with light machines, especially when the heavy machines are of the reciprocating order, such as heavy planers. Heavy machines of this type demand a heavy current at each point of stroke reversal. They cannot well have fly-wheels, except at the motor side of the driving belt, because the back and forward strokes of the machine are done at different speeds, and a fly-wheel is, therefore, inadmissible. It is thus proper for heavy machines to have their own motors, while it is also equally proper that a large number of small machines should have one motor only, the load on which is rendered more uniform with the number of machines it drives. In textile machinery the speed is constant for long periods at a time in a few machines and absolutely so in others. It does not vary widely in any.

In machine tool work machines are fitted in themselves for a wide range of speed. Where a motor can be economically run at wide limits of speed, it will enable the machine which it drives to be simplified to a corresponding degree. When arranging for driving a new works, a balance must be struck between the simplification of the machine and of the motor that drives it. As specially arranged machines are at present more difficult to obtain of satisfactory order than standard machines, this should be remembered when deciding upon the system to be employed. With separate motors to each machine, each motor must have a power in excess of the maximum effort of the machine it drives. Consequently the aggregate power of a dozen separate motors will be nearly or quite double the power of a single motor that would drive the dozen machines in a perfectly satisfactory manner. Separate motors are therefore likely to involve an excessive first cost. For the remodelling of existing works, the separate motor will usually be quite out of the running. Fairly modern places may require little else than the removal of present motive powers in favour of electrical motors, the present motive power being, perhaps, a small steam or gas engine on each line shaft or, perhaps, a pair of bevel wheels, or a belt or rope pulley. Where enormous economies have been effected by means of electrical driving, the cause must be sought in the widely-scattered nature of the works, the comparative fewness of machines, and the great length of shafting, or of more wasteful steam piping, and in the badness of the bearings of the shafting and of the attention, as well as in the low quality of the many small engines employed. But in a textile factory there is but small hope of any economy by electrical driving. Probably about one-fifth the present indicated horse-power could at once be cut out by discarding the main engine and driving each shaft by a separate motor. A really well-driven factory may require 37 tons of coal per 1,000 H.P. per week, or per 800 H.P. delivered to the shafting. The coal bill is, say, £20 per week. The engineer and fireman will still be required to attend to motors and heaters. To supply 800 H.P. for 56 hours per week for £20, will demand that energy must be sold for 0·107d. per H.P.-hour for fuel, to compete with the best present steam practice; allow even one-eighth of a penny per H.P.-hour, or, say, one-sixth of a penny per unit, and it will be seen that where electrical energy is generated from coal, utilised by means of engines with a poor load factor and distributed by cables, there is but little prospect of its competing with independent high-class steam engines in well-arranged factories of the textile type. But there are undoubtedly many factories that use probably three times the amount of coal of our high-class assumed factory, at 50 per cent. greater price. Power must therefore cost these factories about 0·5d. per H.P.-hour, or even 0·7d. per unit.

For second-class factories electrical energy can be supplied at paying rates, while for certain classes of factory using heavy machines which do not run continuously electricity can be purchased to show an economy.

Every case must be considered on its own merits, but upon the general lines above indicated.

CURRENT SPECIFICATIONS.

XCVI.—DEVONPORT (TASMANIA) ELECTRIC LIGHTING.

Summary.

Extent of Contract.—Contract No. 1:—Supply, delivery and erection of two steam dynamos, switchboard and accessories. Contract No. 2:—Supply and erection of one steam boiler, also of iron or steel chimney. Contract No. 3:—Supply and delivery of storage battery.

Output of Steam Dynamos.—Each steam dynamo to develop as normal working load 32 KW.

Specified Overload.—50 per cent. continuously, and 100 per cent. momentarily.

Type of Engine.—Type left open to tenderers, speed also optional, steam pressure 130 lbs. per sq. in. at stop valve, engine to exhaust to atmosphere.

Specified Range of Governing.—To be within 2 per cent. for any sudden load variation.

Steam Consumption.—Not to exceed 20 lbs. per I.H.P.-hour at full load.

Dynamo.—To be shunt-wound, and designed to develop as normal full load 32 KW., or 64 amperes at 500 volts.

Temperature Rise.—With 64 amperes flowing through armature not to exceed, after a long run, 70° F. above surrounding air in either armature or field-magnet winding, or 80° F. on commutator. With 96 amperes flowing for two hours, temperature of any part of machine not to rise more than 100° F. above surrounding atmosphere.

Drop in Voltage.—Not to exceed 8 per cent. between no load and full load with constant speed and excitation.

Combined Efficiency.—When tested at 32 KW. not to be less than 84 per cent.

Balancers and Boosters.—Balancers to be capable of dealing with 25 amperes at 250 volts. Boosters to be reversible and capable of a normal maximum of 30 amperes 60 volts.

Efficiency.—Of each machine not to be less than 90 per cent.

Switchboard.—To comply with specified requirements, and to be suitable for three-wire direct current distribution.

Street Lighting.—Ten enclosed arc lamps and 30 25-C.P. incandescent lamps to be erected as desired.

Crane.—Either a jib or overhead travelling crane of suitable size to be erected.

Boiler.—To be of either locomotive, multitubular or water-tube type, and to be capable of supplying 1,000 lbs. of steam per hour at 150 lbs. pressure, or by forcing 50 per cent. more than this.

Chimney.—To be of iron or steel, 28 in. internal diameter, 65 ft. high.

Battery.—240 cells to be provided and erected in working order, to be capable of discharging at the following rates:—18 amperes for 10 hours, voltage not falling below 1·85 volts per cell; 45 amperes for 3 hours, voltage not falling below 1·82 volts per cell; 100 amperes for 1 hour, voltage not falling below 1·80 volts per cell.

Meters.—Forty integrating watt-hour meters of approved type to be provided.

Overhead Mains.—To be supplied as scheduled, part being double braided and insulated, part bare or single covered.

Specified Date of Completion.—Dates to be stated by tenderers.

Penalty for Late Completion.—£1 per working day.

Terms of Payment.—75 per cent. on certificate of engineer of the value of work actually done, or 50 per cent. on such materials on ground that may have been approved by engineer, balance together with amount deposited for cash security one month after work has been certified by engineer as complete.

Deposit.—£10 per section to be deposited with tender, and a further sum making up 5 per cent. of accepted tender within 14 days of notice being given of acceptance of same.

Stipulations as to Dismissal of Foremen.—See comments.

Stipulations as to Wages to be Paid to Workmen.—Satisfactory.

Arbitration Proposals.—Unsatisfactory. See comments.

Date for Receipt of Tenders.—May 12th, 1902.

This specification, though for a small plant, is interesting from the fact that it has been drawn up and issued in one of the British Colonies. It has been prepared by Mr. William Corin, A.M.I.C.E., engineer to the Devonport Corporation, Tasmania, and, so far as the technical details are concerned, follows very closely British practice.

The plant is required for a small town; the system selected is the three-wire direct current, using 500 volts between the outer conductors and overhead wires. The only noticeable feature is the large margin of overload demanded of the generating plant, viz., 50 per cent. for two hours, and 100 per cent. momentarily. The prices are required in great detail—a practice which, in some cases, is unfair, as it places a large amount of unremunerative work upon unsuccessful tenderers.

The general conditions are, in many points, fair and reasonable, the payment clause providing for entire payment of all claims

particularly apt in relation to Mr. Keen's book. In his

the new special tool steels.

within one month of satisfactory test of plant. This test means the successful running of the station by the contractor for a period of 14 days.

The stipulation giving the engineer power to demand the dismissal of any workman to whom he objects, though reasonable, might conceivably, in a case like this, where the staff is working at a long distance from home, operate in an unjust manner. We notice that the engineer is the sole judge in case of any dispute, and, for reasons which we have many times stated, we strongly object to this proposal. We urge all tenderers to take exception to it in their offers, pointing out how much more satisfactory it would be *to all parties* to have disputes arranged by an independent arbitrator.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1902.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London W.C., and at Liverpool, to whom all inquiries should be addressed.

15,475A. "Improvements in synchronising dynamo-electric machines or motors, or for producing and maintaining synchronous motion between two or more rotating or vibrating bodies." P. M. Justice. (The Rowland Telegraphic Company, U.S.A.) (Date claimed under Patents Rule 19, July 20th, 1901.) March 21st.

6,473. "Improvements in wireless telegraphy." G. L. Hogan. March 17th.

6,478. "Improvements relating to storage batteries." H. C. Porter. March 17th. (Complete.)

6,484. "Improvements in or relating to signalling devices for telephone systems." H. T. Cedergren. (Date applied for under Patents Act, 1901, October 21st, 1901, being date of application in Sweden.) March 17th. (Complete.)

6,485. "Improvements in or relating to telephone systems." H. T. Cedergren. (Date applied for under Patents Act, 1901, October 26th, 1901, being date of application in Sweden.) March 17th. (Complete.)

6,567. "An improved method of constructing contact faces in swivelling connectors for cables in trolleys, or collectors used for electrically-propelled vehicles and the like." H. Brecknell, E. M. Muneo, and H. I. Rogers. March 18th.

6,607. "Improved lifeguard for engines and cars, and any vehicle worked by animal or any mechanical or electric power on rails or common roads." H. Conradi and E. S. Conradi. March 18th.

6,648. "Improvements in signal telegraphs." E. Lavens and E. J. Lavens. March 18th.

6,652. "Improvements relating to the controlling of electric circuits." E. N. Bray. March 18th.

6,653. "Improvements relating to the controlling of electric circuits." E. N. Bray. March 18th.

6,654. "Improvements relating to switches." E. N. Bray. March 18th.

6,666. "Improvements in dynamo-electric machinery." J. H. St. Hill Mawdsley. March 18th.

6,684. "Improvements in incandescent electric lamps." G. Hookham. March 19th.

6,686. "Improvements relating to switches for electric motors." R. J. Appleton and J. Oulton. March 19th.

6,714. "Improvements in means for coating or impregnating boxes, cisterns and the like, with resin, pitch, bitumen, and similar insulating compositions." G. F. Priestley. March 19th.

6,726. "Improvements in and relating to incandescent electric lamps for decorative and other purposes." T. Wohlmuth. March 19th.

6,733. "Improved apparatus for the regulation of electrical circuits in heating devices." W. D. Kilroy. March 19th.

6,760. "Improvements in the production of fluid tight joints for electrical and other purposes, and in centreing." W. McLellan. March 19th.

6,794. "Stereoscopic localiser for X ray investigation." J. B. Carter. March 20th.

6,817. "Improvements in telephone sets." J. E. Kingsbury. (The Bell Telephone Manufacturing Company, Belgium.) March 20th.

6,818. "Improvements in flexible conducting cords applicable especially for use in the plug circuits of telephone switchboards." J. E. Kingsbury. (The Western Electric Company, United States.) March 20th.

6,850. "Improvement connected with ceiling roses for electric incandescent lighting." E. Schulz. March 20th.

6,854. "An improved system of electrical distribution." P. A. Newton. (Bliss Electric Car Lighting Company, United States.) March 20th. (Complete.)

6,855. "Improvements in brush mechanism for dynamos." P. A. Newton. (Bliss Electric Car Lighting Company, United States.) March 20th. (Complete.)

6,880. "Improvements in electrical heating devices." G. C. Marks. (G. L. Dengler, United States.) March 20th.

6,884. "Improvements in telephonic apparatus." A. Graham. March 20th.

6,898. "An automatic safety device applicable to the trolley arm, used in connection with electrical tramways." W. Pickering, S. A. Pickering and J. Bromley. March 21st.

6,947. "Improvements in connections for electric cables." Callender's Cable and Construction Company, Limited, and H. Hastings. March 21st.

6,948. "Improvements in the feeder pillars used in connection with electric supply mains." Callender's Cable and Construction Company, Limited, and T. Petersen. March 21st.

7,003. "Improvements in incandescent electric lamps." N. Cleminson, J. W. Butterworth and A. Morrison. March 22nd.

7,039. "Improvements in electric fuses." S. Z. de Ferranti. March 22nd.

7,062. "Improvements in or relating to overhead trolleys for electric vehicles." F. Haller and R. Noiset. March 22nd. (Complete.)

7,075. "Improvements in multiplex telephony, telegraphy, and the transmission of electrical impulses and vibrations." G. L. Hogan. March 22nd.

7,079. "Improvements in and relating to microphones." E. Schmidmer and G. E. Schmidmer. March 22nd.

7,080. "An improved electro-magnetic instrument." W. M. Thornton. March 22nd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1900.

3,834. "Improvements in and relating to electric generators and motors." H. W. Storer. (Date applied for under Sec. 103, Patents, &c., Act, 1883, July 28th, 1899.) Dated February 27th, 1900. Armatures, Commutators.—In an armature having a slotted core, and a winding composed of a number of layers of conductors located in the core slots, the conductors which lie side by side in each slot are connected to the same commutator bar. A winding is shown made up of twice as many coils as there are slots in the core, one side of each coil being situated in the bottom of one slot and the other side in the top of another slot. 2 claims.

3,878. "Improvements in alarm apparatus for engine room, telegraphs, or the like." T. Bell. Dated February 28th, 1900. Relates to alarm apparatus for use in connection with engine room, telegraphs, &c., the arrangement being such that an alarm bell rings as long as the order transmitted is not complied with. 4 claims.

3,913. "Improvements in or connected with the measuring of electricity." A. Wright and Reason Manufacturing Company. Dated February 29th, 1900. The whole or part of the electric conductor of a maximum-demand indicator is used as a shunt resistance for a quantity or energy meter, in order to keep the total fall of pressure in supply-measuring apparatus as low as possible. The maximum indicator may be one in which liquid is caused to overflow into a measuring-tube by the expansion of gas heated by a main resistance, or one of the thermal or electro-magnetic forms described in Specification No. 5,451, A.D. 1895, or a strip of two metals carrying a plunger to displace liquid into a measuring tube. The meter may be a mercury voltmeter described in Specification No. 2,222, A.D. 1900. 4 claims.

3,917. "Improvements in electricity meters." J. Lorwa. Dated February 28th, 1900. Counting mechanism is periodically driven, for times depending on the downward deflection of an arm on the axle of a wattmeter, by a friction coupling on a uniformly rotating shaft, when the coupling is not held stationary by teeth on it engaging a spring on a lever; the lever is periodically moved away from the teeth by a conical surface on the shaft bearing against the end of the arm, which bears against a curved extension of the lever. The time during which the lever is held away from the teeth depends on the position of the arm, the conical surface being formed by curving a triangular plate, the base of which is long enough to compensate for the deviation of the end of the arm from a vertical path, and so cause the times to be proportional to the angular deflections of the arm. When no current is passing, a pin carried by the axle of the wattmeter prevents rotation of the shaft by engaging a star-wheel geared to it, and in order to allow disengagement of the star-wheel when current passes, the arm is connected with the axle by a pin and slot, which permit the axle to turn independently of the arm if this is held up by the cone. 2 claims.

3,922. "Improvements in holders for electric incandescent lamps." J. H. F. Krull. Dated February 28th, 1900. Incandescent lamps are enclosed in globes on portable air-tight and water-tight holders, for use by miners, divers, and others. 1 claim.

3,933. "Improvements in the method of, and apparatus for reversing the trolley in electric tram." J. W. Oldfield. Dated March 1st, 1900. Electric railways and tramways with overhead collectors. Relates to means for reversing the trolleys. 7 claims.

3,937. "Apparatus for indicating and recording electric pressure and current." W. Thomson, Baron Kelvin. Dated March 1st, 1900. Electric pressure and current are recorded continuously on the upper and lower parts of paper on a rotating drum, by pens moving in one vertical line. The pens are attached to weighted pointers, sliding on vertical guides near a fixed scale, hung by threads or fine wires from sector levers, which at their other ends similarly carry iron cores in vertical solenoids, one connected in series with a resistance to carry the pressure, and the other carrying the current to be measured. Each sector lever has two screw-threaded arms set at right angles to each other, and carrying adjustable weights. The paper drum is driven by a clock or other motor, and carried on a base having three feet, to fit grooved and plane parts of the bottom of the containing case. The base also has a quadrant passed through a slot in the bottom of the case; the drum may be drawn forward and turned down to a horizontal position in front of the case, when the paper is to be changed, being so supported by projections on the end of the quadrant engaging under the base. The provisional specification states that the front of the case is hinged thereto at the top by two pins lying in slots, so that the front can be turned up and then slid back on the case. 3 claims.

3,949. "An improved electrical speed apparatus." R. F. Collings and R. J. Collard. Dated March 1st, 1900. The speed of a wheel, axle, or shaft of a vehicle, &c., is determined by causing it to drive a shunt-wound dynamo, the terminals of which are connected to the terminals of a galvanometer or the like instrument, the scale of which is calibrated in units of speed. The dynamo is protected from external influences by an iron casing. 1 claim.

3,968. "Improvements in recording instruments for electric telegraphs." A. Muirhead and R. H. Kharkala. Dated March 1st, 1900. Relates to improvements in siphon recorders of the type described in Specification No. 20,793, A.D. 1893. A coil is suspended by two adjustable threads or is pivoted to a stationary core between the magnet poles, a mirror being fixed opposite an opening. The coil is provided with pins upon which a yoke can engage or can be disengaged from the pins by a sliding and pivoted fork lever. The yoke carries fibres connecting to the siphon cradle, springs being inserted in the fibres. The cradle is supported above the two wires arranged to pass over a guide-edge or equivalent arrangement, adjustments being provided for regulating the period of oscillation, the zero and vertical position being a lower tensional single spring. The siphon appurtenances are mounted on an adjustable bracket, the ink-well and paper support being separately adjustable. The coil is double-wound, one part being in a shunt connection with a variable resistance. 8 claims.

3,992. "Improvements in voltmeters." W. L. Wise. Dated March 1st, 1900. Electrometers.—A voltmeter has an axle supported between pivots and carrying a pointer and an adjustable sleeve on which are several vanes, movable from between stationary metal plates towards curved metal rods. The rods, vanes, or stationary plates are not exactly superposed, but are set at different angles, to increase the evenness of gradation of the scale over which the pointer moves. The vanes may be solid plates, or may be cut out, for lightness. The plates and the vanes are connected to one terminal, and the rods to the other. The terminals are also connected to an adjustable discharger, such as a point, and plate to protect the measuring parts from excessive electric pressures. 4 claims.

4,046. "Improvements in and connected with fusible cut-out for electric installations." C. A. Hemingway and R. J. Coley. Dated March 2nd, 1900. A fusible cut-out is provided with a second fuse which carries the current should the first fuse be broken accidentally or by a momentarily excessive current. 2 claims.

4,109. "An improved electric clock." F. W. Colby. Dated March 3rd, 1900. Electric clocks.—The minute hand of a master clock completes the circuit of electro-magnets every minute, and the armatures of the latter drive pairs of wheels, both of which have 60 teeth, but one of which is masked by the other except at every 12th tooth. The arbor of one wheel bears the lever hand, and that of the other the minute hand. The striking hammer of the master clock puts into circuit electric bells in the indicators. 1 claim.

4,122. "Improvements in switch contacts for use in electrical ignition devices for Multi-cylinder explosion motors." E. Kuhlstein and J. Vollmer. Dated March 3rd, 1900. In multi-cylinder engines, one switch is employed to complete the secondary circuit of an induction coil to each cylinder in turn. 2 claims.

which class factories electrical energy can be supplied at

the payment clause providing for entire payment of all claims